Structure of Atom

Question1

The energy of an electron in the first Bohr orbit of the H-atom is -13.6 eV.

The magnitude of energy value of an electron in the first excited state of Be^{3+} is _____ eV (nearest integer value).

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Answer: 54

Solution:

To find the energy of an electron in the first excited state of a Be^{3+} ion, we can use the formula for the energy of an electron in a hydrogen-like atom:

$$E_T = -13.6\frac{Z^2}{n^2} \text{ eV}$$

Given:

Energy of the first orbit (ground state) of the hydrogen atom: $E_1 = -13.6$ eV (where $Z = 1$ and $n = 1$).

For Be^{3+}:

Atomic number $Z = 4$.

First excited state corresponds to $n = 2$.

Calculation for Be^{3+}:

The energy ratio between the hydrogen atom and the Be^{3+} ion can be written as:

$$\frac{E_H}{E_{Be^{+3}}} = \frac{Z_1^2}{n_1^2} \times \frac{n_2^2}{Z_2^2}$$

Substitute the known values:

$\frac{-13.6}{E_{Be^{+3}}} = \frac{1^2}{1^2} \times \frac{2^2}{4^2}$

$\frac{-13.6}{E_{Be^{+3}}} = \frac{1}{1} \times \frac{4}{16}$

Solving this gives:

$E_{Be^{+3}} = -13.6 \times 4 = -54.4 \text{ eV}$

The magnitude of the energy of the electron in the first excited state of Be^{3+} is $|-54.4| = 54.4$ eV, which is approximately 54 eV when rounded to the nearest integer.

Question2

Radius of the first excited state of Helium ion is given as : $a_0 \rightarrow$ radius of first stationary state of hydrogen atom.

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Options:

A. $r = \frac{a_0}{4}$

B. $r = 2a_0$

C. $r = 4a_0$

D. $r = \frac{a_0}{2}$

Answer: B

Solution:

$r_n = \frac{n^2 a_0}{Z}$

For the helium ion, which is hydrogen-like with a nuclear charge of $Z = 2$, the first excited state corresponds to $n = 2$. Substituting these values:

$r_2 = \frac{(2)^2 a_0}{2} = \frac{4 a_0}{2} = 2 a_0$

Thus, the radius of the first excited state of the helium ion is $2 a_0$.

Question3

Given below are two statements :

Statement (I) : A spectral line will be observed for a $2p_x \rightarrow 2p_y$ transition.

Statement (II) : $2\mathrm{p}_x$ and $2\mathrm{p}_y$ are degenerate orbitals.

In the light of the above statements, choose the correct answer from the options given below :

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Options:

A. Statement I is false but Statement II is true

B. Both Statement I and Statement II are false

C. Statement I is true but Statement II is false

D. Both Statement I and Statement II are true

Answer: A

Solution:

Let us analyze the two statements in the context of atomic orbitals and electronic transitions:

Statement (I)

> "A spectral line will be observed for a $2p_x \rightarrow 2p_y$ transition."

For an emission (or absorption) line to be observed, there must be a difference in energy between the initial and final states.

In a typical hydrogen-like or many-electron atom (without additional external fields or splitting effects), the three $2p$ orbitals ($2p_x$, $2p_y$, $2p_z$) are *degenerate*—i.e., they all have the same energy.

Consequently, a transition from $2p_x$ to $2p_y$ (both having the same energy) would involve **no energy change**. Hence, **no photon** is emitted or absorbed for this "transition." So you **would not** observe a spectral line for such a transition.

Therefore, **Statement (I)** is **false**.

Statement (II)

> "$2p_x$ and $2p_y$ are degenerate orbitals."

Orbitals within the same subshell (e.g., $2p$ subshell) are typically degenerate (same energy) in an isolated atom (especially a hydrogen-like atom).

Thus, $2p_x$ and $2p_y$ (and $2p_z$) do indeed have the same energy.

Therefore, **Statement (II)** is **true**.

Conclusion

Statement (I): **False**

Statement (II): **True**

Hence, the correct choice is:

> **Option A: Statement I is false but Statement II is true.**

Question4

Heat treatment of muscular pain involves radiation of wavelength of about 900 nm . Which spectral line of H atom is suitable for this?

Given : Rydberg constant

$\mathrm{R_H} = 10^5\ \mathrm{cm}^{-1},\ \mathrm{h} = 6.6 \times 10^{-34}\ \mathrm{J\ s}, \mathrm{c} = 3 \times 10^8\ \mathrm{m/s}\Big)$

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Options:

A. Lyman series, $\infty \rightarrow 1$

B. Balmer series, $\infty \rightarrow 2$

C. Paschen series, $5 \rightarrow 3$

D. Paschen series, $\infty \rightarrow 3$

Answer: D

Solution:

To determine which spectral line of the hydrogen atom suits the wavelength for heat treatment of muscular pain (900 nm), we begin by applying the Rydberg equation:

$\frac{1}{\lambda} = \mathrm{R_H Z^2} \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$

Given:

$\lambda = 900 \text{ nm} = 9 \times 10^{-5} \text{ cm}$

$\mathrm{R_H} = 10^5 \text{ cm}^{-1}$

Hydrogen atom (Z = 1)

We proceed by solving the equation:

$\frac{1}{\lambda \times \mathrm{R_H}} = \frac{1}{n_1^2} - \frac{1}{n_2^2}$

Substituting the known values:

$\frac{1}{9 \times 10^{-5} \text{ cm } \times 10^5 \text{ cm}^{-1}} = \frac{1}{n_1^2} - \frac{1}{n_2^2}$

This simplifies to:

$\frac{1}{9} = \frac{1}{n_1^2} - \frac{1}{n_2^2}$

This condition is satisfied when $n_1 = 3$ and $n_2 = \infty$.

Therefore, the appropriate spectral transition is from $n_2 = \infty$ to $n_1 = 3$, which corresponds to the Paschen series transition $\infty \rightarrow 3$.

Question5

Given below are two statements about X-ray spectra of elements :

Statement (I) : A plot of $\sqrt{v}$ ($v =$ frequency of X-rays emitted) vs atomic mass is a straight line.

Statement (II) : A plot of $v(\nu =$ frequency of X-rays emitted) vs atomic number is a straight line. In the light of the above statements, choose the correct answer from the options given below :

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Options:

A. Statement I is false but Statement II is true

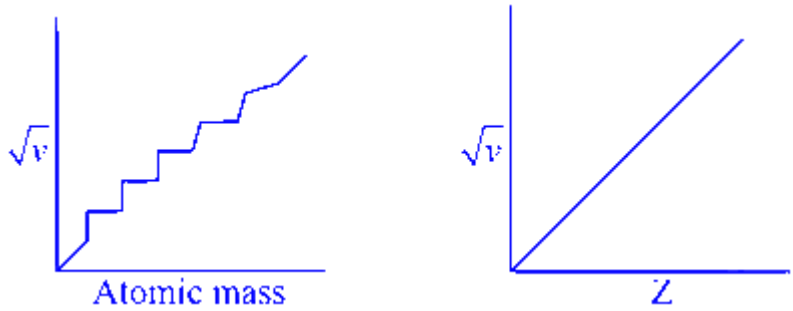
B. Both Statement I and Statement II are true

C. Statement I is true but Statement II is false

D. Both Statement I and Statement II are false

Answer: D

Solution:



Question6

Given below are two statements :

Statement (I) : For a given shell, the total number of allowed orbitals is given by n^2.

Statement (II) : For any subshell, the spatial orientation of the orbitals is given by $-l$ to $+l$ values including zero.

In the light of the above statements, choose the correct answer from the options given below :

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Options:

A. Both Statement I and Statement II are true

B. Both Statement I and Statement II are false

C. Statement I is false but Statement II is true

D. Statement I is true but Statement II is false

Answer: A

Solution:

For a shell total number of orbitals $= \mathrm{n}^2$

Magnetic quantum number have values $(-\ell$ to $+\ell)$ including 0.

Question7

For hydrogen atom, the orbital/s with lowest energy is/are :

(A) $4\mathrm{s}$

(B) $3\mathrm{p}_x$

(C) $3\ \mathrm{d}_{x^2-y^2}$

(D) $3\ \mathrm{d}_{z^2}$

(E) $4\mathrm{p}_z$

Choose the correct answer from the options given below :

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Options:

A. (A) only

B. (B) only

C. (B), (C) and (D) only

D. (A) and (E) only

Answer: C

Solution:

In hydrogen atom the orbitals in a shell are degenerate means energy depends only on ' n '

$\therefore \mathrm{E}_{3\mathrm{p}_\mathrm{x}} = \mathrm{E}_{3\ \mathrm{d}_{x^2-y^2}} = \mathrm{E}_{3\ \mathrm{d}_{z^2}}$

Question8

In a multielectron atom, which of the following orbitals described by three quantum numbers will have same energy in absence of electric and magnetic fields?

A. $\mathrm{n} = 1, \mathrm{l} = 0,\ \mathrm{m}_1 = 0$

B. $\mathrm{n} = 2, \mathrm{l} = 0,\ \mathrm{m}_1 = 0$

C. $\mathrm{n} = 2, \mathrm{I} = 1,\ \mathrm{m}_1 = 1$

D. $\mathrm{n} = 3, \mathrm{l} = 2,\ \mathrm{m}_1 = 1$

E. $\mathrm{n} = 3, \mathrm{l} = 2,\ \mathrm{m}_1 = 0$

Choose the correct answer from the options given below:

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Options:

A. B and C Only

B. C and D Only

C. A and B Only

D. D and E Only

Answer: D

Solution:

	orbital
$A : n = 1, \ell = 0, \ m_\ell = 0$	1s
$B : n = 2, \ell = 0, \ m_\ell = 0$	2s
$C : n = 3, \ell = 1, \ m_\ell = 1$	3p
$D : n = 3, \ell = 2, \ m_\ell = 1$	3d
$E : n = 3, \ell = 2, \ m_\ell = 0$	3d

In absence of electric and magnetic fields, all orbitals of 3d are degenerate

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Question9

Which of the following is/are not correct with respect to energy of atomic orbitals of hydrogen atom?

(A) 1s < 2p < 3d < 4s

(B) 1s < 2s = 2p < 3s = 3p

(C) 1s < 2s < 2p < 3s < 3p

(D) 1s < 2s < 4s < 3d

Choose the correct answer from the options given below :

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Options:

A.

(A) and (B) only

B.

(A) and (C) only

C.

(B) and (D) only

D.

(C) and (D) only

Answer: D

Solution:

First, recall the key fact that **for a hydrogen atom (and hydrogen-like ions)**, all orbitals having the same principal quantum number n have the **same energy**. In other words,

$E_{n\ell}$ depends only on n, and not on ℓ.

Hence, the energy ordering for hydrogen-like atoms follows

$1s \ < \ 2s = 2p \ < \ 3s = 3p = 3d \ < \ 4s = 4p = 4d = 4f \ < \ \dots$

Analyzing Each Statement

We check each statement against the **true** ordering for the hydrogen atom.

(A) $1s < 2p < 3d < 4s$

Because $2p$ is an $n = 2$ orbital, $3d$ is $n = 3$, and $4s$ is $n = 4$, this partial ordering

$E(1s) \ < \ E(2p) \ < \ E(3d) \ < \ E(4s)$

is consistent with the fact that $n = 1 < n = 2 < n = 3 < n = 4$.

Even though hydrogen also has 2s degenerate with 2p, and 3s and 3p degenerate with 3d, **nothing in (A) contradicts** the correct order $E_1 < E_2 < E_3 < E_4$.

So (A) is **correct** for hydrogen's energy levels as stated.

(B) $1s < 2s = 2p < 3s = 3p$

For hydrogen, indeed $2s = 2p$ in energy, and also $3s = 3p = 3d$.

The statement does *not* mention 3d, but it does correctly say $3s = 3p$. That part is still true for hydrogen.

So for the orbitals it listed, (B) is also **correct**.

(C) $1s < 2s < 2p < 3s < 3p$

This is the kind of ordering that appears in many-electron atoms (where subshell splitting occurs).

But for a hydrogen atom, $2s$ and $2p$ have exactly the **same** energy, so $2s < 2p$ is **not** correct.

Hence (C) is **not** correct for hydrogen.

(D) $1s < 2s < 4s < 3d$

In multi-electron atoms (e.g. the usual "(n+ℓ) rule"), often $4s$ is lower than $3d$.

But for hydrogen, *all* orbitals with $n = 3$ lie below *all* orbitals with $n = 4$. That is, $3d$ is lower in energy than $4s$.

So (D) is **not** correct for hydrogen.

Conclusion

(C) and (D) are **not correct** for the hydrogen atom.

(A) and (B) are correct.

Hence the final answer matches the choice stating:

> **(C) and (D) only** are not correct.

Looking at the given options, that is:

Option (D): (C) and (D) only.

Question10

If a_0 is denoted as the Bohr radius of hydrogen atom, then what is the de-Broglie wavelength (λ) of the electron present in the second orbit of hydrogen atom? [n : any integer]

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Options:

A.

$\frac{8\pi a_0}{n}$

B.

$\frac{2a_0}{n\pi}$

C.

$\frac{na_0}{4\pi}$

D.

$\frac{4\pi a_0}{n}$

Answer: A

Solution:

Bohr radius of hychogon atom $\rightarrow a_0$

According to Bohr, the equation used to calculate the angular momentum of an election in a hydrogen atom is

$\mathrm{mvr} = \frac{\mathrm{nh}}{2\pi}$ ..... (1)

$m \rightarrow$ mass of electron

$v \rightarrow$ velocity of electron

$r \rightarrow$ radius of the orbit

$n \rightarrow$ orbit. number. in. which electron is present.

Given that; election is present in second orbit, $n = 2$

The radius of the second orbit $r_2 = a_0 \times 2^2 = 4a_0$

General formula for radius of n^{th} orbit,

$r_n = a_0 \times n^2$

From (1)

$$mvr = n\frac{h}{2\pi}$$
$$2\pi r = n\frac{h}{mv}$$

$\frac{h}{mv} = \lambda$ (de Broglie relation ship, $\lambda \rightarrow$ de Broglie Wavelength

So, $2\pi r = n\lambda$

For the electron in the second orbit, $2\pi r_2 = n\lambda$

Substitute for r_2,

$2\pi \times 4a_0 = n\lambda$
$8\pi a_0 = n\lambda$
$$\therefore \lambda = \frac{8\pi a_0}{n}$$

Correct answer: Option 1) $\frac{8\pi a_0}{n}$

Question11

Given below are two statements :

Statement (I): It is impossible to specify simultaneously with arbitrary precision, both the linear momentum and the position of a particle.

Statement (II) : If the uncertainty in the measurement of position and uncertainty in measurement of momentum are equal for an electron, then the uncertainty in the measurement of velocity is $\geqslant \sqrt{\frac{h}{\pi}} \times \frac{1}{2m}$.

In the light of the above statements, choose the correct answer from the options given below :

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Options:

A.

Statement I is false but **Statement II** is true

B.

Both **Statement I** and **Statement II** are true

C.

Both **Statement I** and **Statement II** are false

D.

Statement I is true but **Statement II** is false

Answer: B

Solution:

Statement I : Correct

This statement is describing the uncertainty principle.

It states that it is impossible to measure both the position and the momentum of an object.

Statement II : Correct.

If the uncertainty in the measurement of position (Δx) and the uncertainty in the measurement of momentum (Δp) are equal for an electron, then the uncertainty in the measurement of velocity (Δv) is greater than or equal to $\sqrt{\frac{h}{\pi}}\frac{1}{2m}$

This is derived from the Heisenberg uncertainty principle, $\Delta x\,.\,\Delta p_x \geq \frac{h}{4\pi}$

Given, $\Delta x = \Delta p$

Substitute this in $\Delta x\,.\,\Delta p \geq \frac{h}{4\pi}$ as

$\Delta p\,.\,\Delta p \geq \frac{h}{4\pi}$

$\Delta p^2 \geq \frac{h}{4\pi}$

$\Delta p^2 \geq \frac{h}{4\pi}$

$\begin{cases} The\ formula\ for\ momentum\ (P)\ is\ P = mV \\ For\ uncertainty\ \Delta P = m\Delta v \end{cases}$

So, $m\Delta v \geq \sqrt{\frac{h}{4\pi}}$

$\Delta v \geq \sqrt{\frac{h}{4\pi}} \times \frac{1}{m}$

$\Delta v \geq \frac{1}{2} > \sqrt{\frac{h}{\pi}} > \frac{1}{m}$

$\Delta v \geq \sqrt{\frac{h}{\pi}}\frac{1}{2m}$

Both the statements are true (correct). So answer is (2) Both statement I and statement II are true.

Question12

For hydrogen like species, which of the following graphs provides the most appropriate representation of E vs Z plot for a constant n?

[E : Energy of the stationary state, Z : atomic number, n = principal quantum number]

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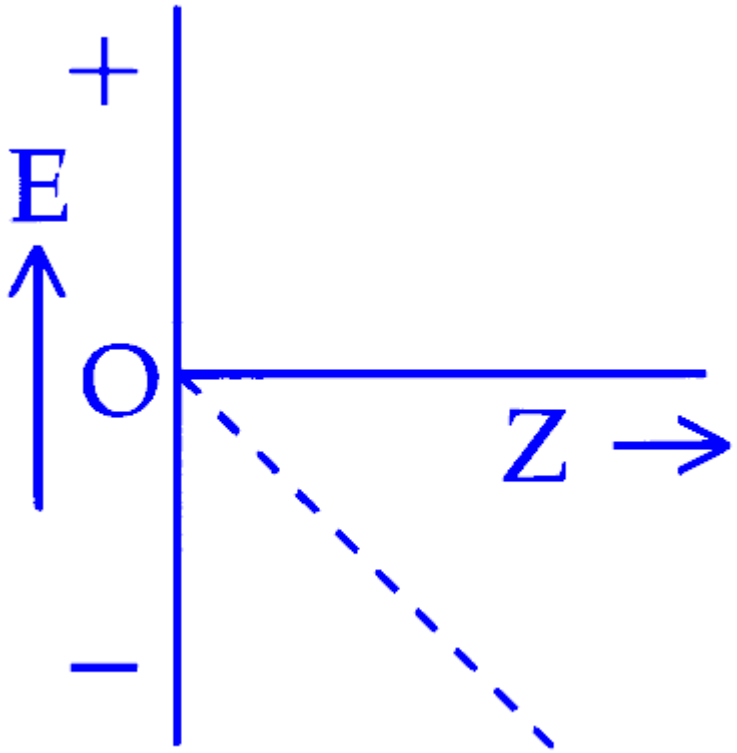
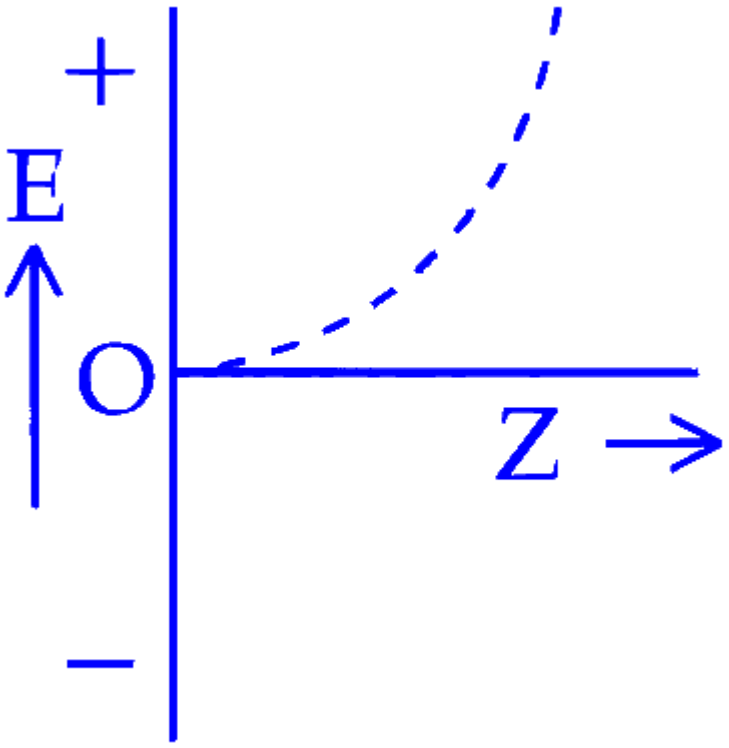
Options:

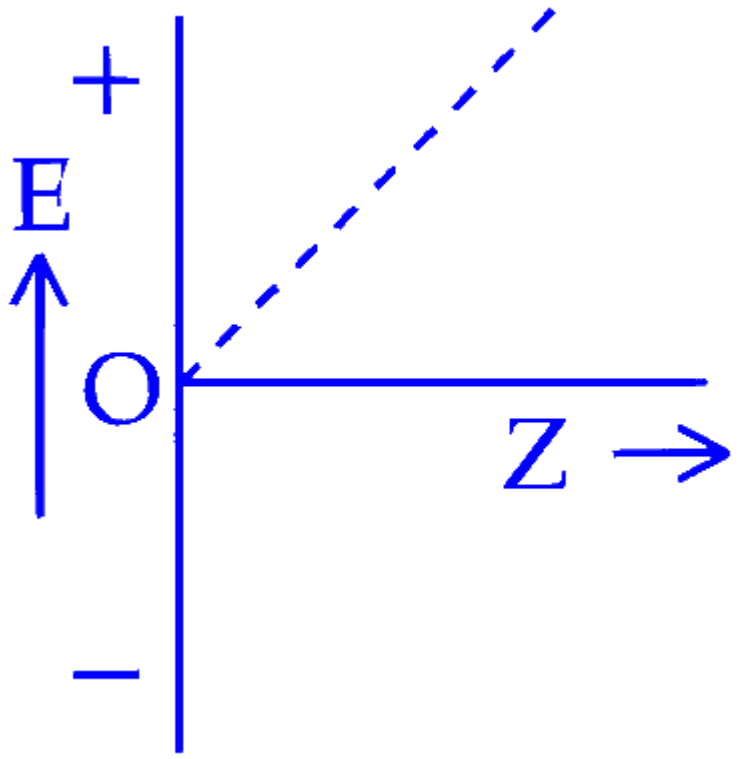
A.



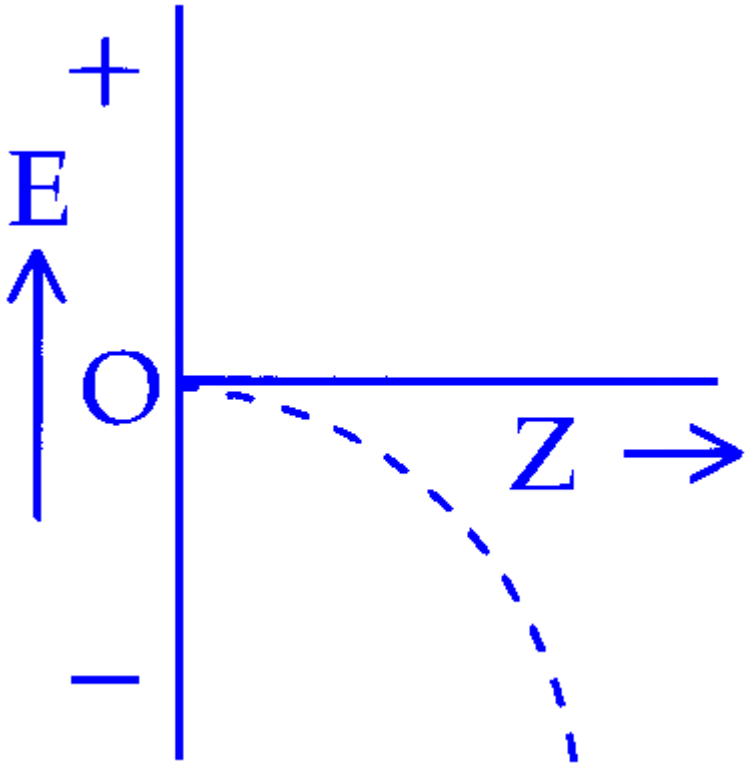
B.



C.



D.



Answer: D

Solution:

$$E\,vs\,Z\,plot\,(cons\tan t\,n)\begin{cases}E-Energy\,of\,the\,stationary\,state\\Z-atomic\,number\\n-\Pr incipal\,quantum\,number\end{cases}$$

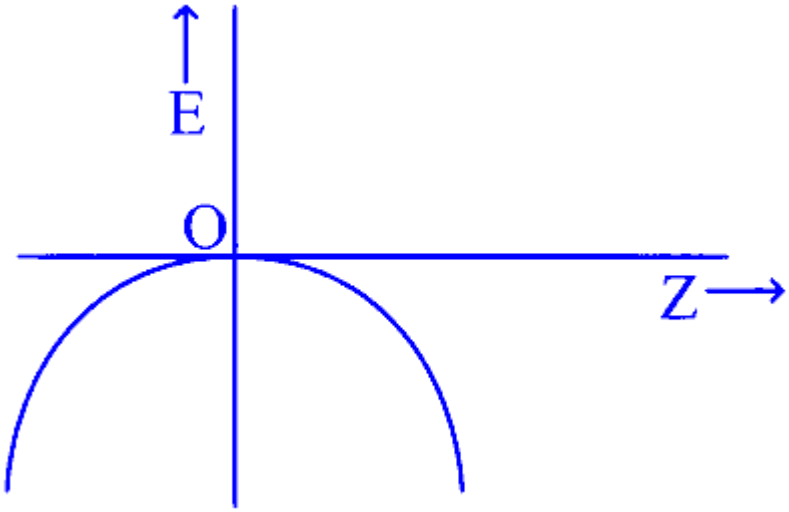
The formula of energy of hydrogen like species is

$E = -13.6\frac{z^2}{n^2}eV$

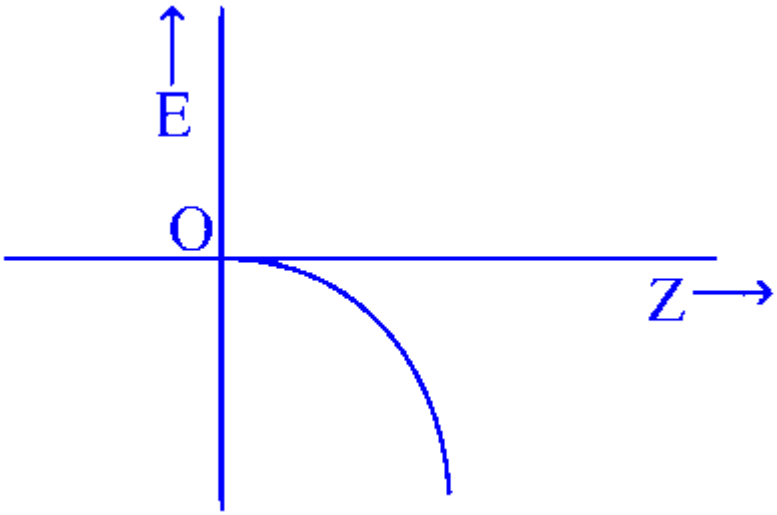
$E \propto -\frac{z^2}{n^2}$

For constant n, $E \propto -Z^2$

Here, E and Z has a quadratic relationship. Since the equation (proportionality) includes a negative sign, the graph of E vs Z will be a downward - opening parabola.



The graph is like an upside down U. In the given options, graph 4 is like half upside down parabola.



The shape is characteristic of negative quadratic function, where the curve opens downward, with the vertex of the parabola at the origin.

So, the answer is option (4).

Question13

According to Bohr's model of hydrogen atom, which of the following statement is incorrect?

JEE Main 2025 (Online) 2nd April Morning Shift

Options:

A. Radius of 4^{th} orbit is four times larger than that of 2^{nd} orbit

B. Radius of 8^{th} orbit is four times larger than that of 4^{th} orbit

C. Radius of 6^{th} orbit is three times larger than that of 4^{th} orbit

D. Radius of 3^{rd} orbit is nine times larger than that of 1^{st} orbit

Answer: C

Solution:

In Bohr's model the radius of the nth orbit is

$r_n = n^2\, a_0$

where a_0 is the Bohr radius. Hence for any two orbits m and n:

$\frac{r_m}{r_n} = \frac{m^2}{n^2}$.

Let's check each option:

A: $\frac{r_4}{r_2} = \frac{4^2}{2^2} = \frac{16}{4} = 4 \rightarrow$ correct

B: $\frac{r_8}{r_4} = \frac{8^2}{4^2} = \frac{64}{16} = 4 \rightarrow$ correct

C: $\frac{r_6}{r_4} = \frac{6^2}{4^2} = \frac{36}{16} = 2.25\ (\neq 3) \rightarrow$ incorrect

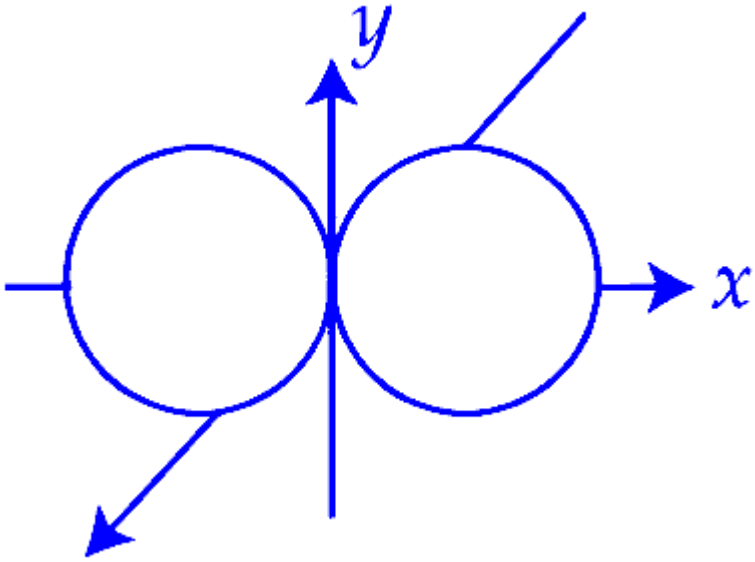
D: $\frac{r_3}{r_1} = \frac{3^2}{1^2} = 9 \rightarrow$ correct

Therefore the incorrect statement is Option C.

Question14

Which of the following statements are true?

(A) The subsidiary quantum number l describes the shape of the orbital occupied by the electron.

(B) 

is the boundary surface diagram of the $2\mathrm{p}_x$ orbital.

(C) The + and - signs in the wave function of the $2p_x$ orbital refer to charge.

(D) The wave function of $2\mathrm{p}_x$ orbital is zero everywhere in the xy plane.

Choose the correct answer from the options given below :

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Options:

A. (A) and (B) only

B. (B) and (D) only

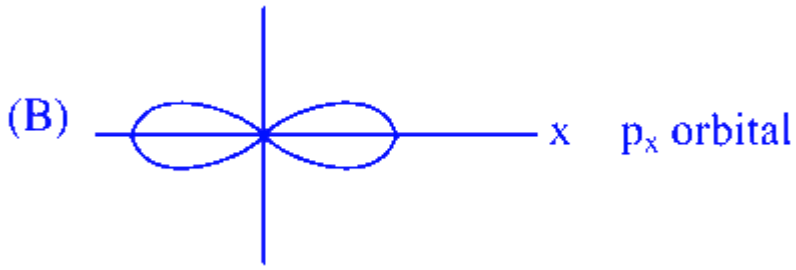
C. (C) and (D) only

D. (A), (B) and (C) only

Answer: A

Solution:

(A) Azimuthal quantum number (ℓ) indicates the shape of orbital occupied by the electron



(C) The + and - sign in the wave function of $2p_x$ orbital refer to the sign (Phase) of the wave function, not the charge

(D) The wave function of $2p_x$ orbital will be zero in yz plane (Nodal plane).

Question15

Which of the following postulate of Bohr's model of hydrogen atom is not in agreement with quantum mechanical model of an atom?

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Options:

A. The electron in a H atom's stationary state moves in a circle around the nucleus.

B. An atom can take only certain distinct energies E_1, E_2, E_3, etc. These allowed states of constant energy are called the stationary states of atom.

C. An atom in a stationary state does not emit electromagnetic radiation as long as it stays in the same state.

D. When an electron makes a transition from a higher energy stationary state to a lower energy stationary state, then it emits a photon of light.

Answer: A

Solution:

The postulate that contradicts quantum mechanics is

Option A

“The electron in a H atom’s stationary state moves in a circle around the nucleus.”

In quantum mechanics an electron in a stationary state is described by a delocalized wave-function (an orbital), not by a definite circular orbit.

Question16

For electrons in ' 2 s ' and ' 2 p ' orbitals, the orbital angular momentum values, respectively are :

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Options:

A. 0 and $\sqrt{6}\frac{h}{2\pi}$

B. 0 and $\sqrt{2}\frac{h}{2\pi}$

C. $\sqrt{2}\frac{h}{2\pi}$ and 0

D. $\frac{h}{2\pi}$ and $\sqrt{2}\frac{h}{2\pi}$

Answer: B

Solution:

The orbital angular momentum for electrons in orbitals is given by the formula:

Orbital angular momentum $= \sqrt{\ell(\ell+1)}\frac{\mathrm{h}}{2\pi}$

For the 2s orbital, the quantum number ℓ is 0:

Orbital angular momentum = $\sqrt{0(0+1)}\frac{\mathrm{h}}{2\pi} = 0$

For the 2p orbital, the quantum number ℓ is 1:

Orbital angular momentum = $\sqrt{1(1+1)}\frac{\mathrm{h}}{2\pi} = \sqrt{2}\frac{\mathrm{h}}{2\pi}$

Question17

Which one of the following about an electron occupying the 1 s orbital in a hydrogen atom is incorrect?

(Bohr's radius is represented by a_0)

JEE Main 2025 (Online) 4th April Morning Shift

Options:

A. The probability density of finding the electron is maximum at the nucleus

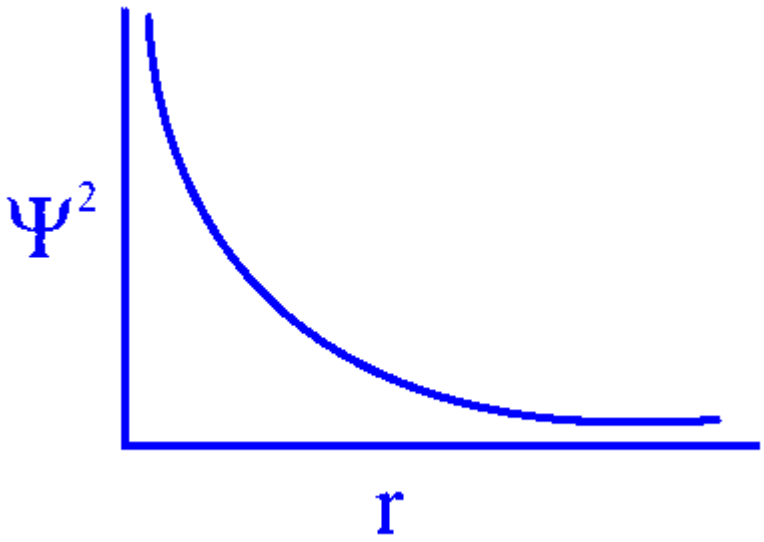
B. The total energy of the electron is maximum when it is at a distance a_0 from the nucleus

C. The electron can be found at a distance $2a_0$ from the nucleus

D. The 1 s orbital is spherically symmetrical

Answer: B

Solution:



1. Ψ^2 = Probability density is maximum at nucleus.

2. Electron can exist upto infinity from nucleus.

3. True

4. Energy of electron is maximum at infinite distance from nucleus.

Question18

Consider the ground state of chromium atom $(Z = 24)$. How many electrons are with Azimuthal quantum number $l = 1$ and $l = 2$ respectively ?

JEE Main 2025 (Online) 4th April Evening Shift

Options:

A. 16 and 5

B. 12 and 5

C. 12 and 4

D. 16 and 4

Answer: B

Solution:

The ground state electron configuration of chromium (Cr, $Z = 24$) is:

Cr: $[\text{Ar}]\, 3d^5\, 4s^1$

Let's break down the configuration:

The noble gas core $[\text{Ar}]$ represents:

$1s^2$ (with $l = 0$)

$2s^2$ (with $l = 0$)

$2p^6$ (with $l = 1$)

$3s^2$ (with $l = 0$)

$3p^6$ (with $l = 1$)

Electrons with azimuthal quantum number $l = 1$ are found in p orbitals:

$2p^6$: 6 electrons

$3p^6$: 6 electrons

Total p-electrons: $6 + 6 = 12$.

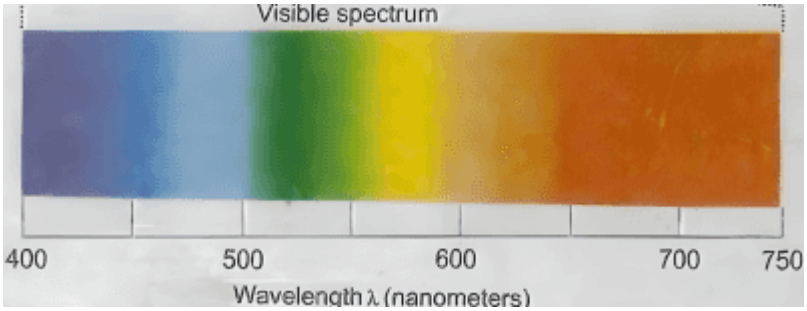
Electrons with azimuthal quantum number $l = 2$ are found in d orbitals:

$3d^5$: 5 electrons

Thus, there are 12 electrons with $l = 1$ and 5 electrons with $l = 2$.

The correct option is Option B.

Question19



Which of the following statements are correct, if the threshold frequency of caesium is 5.16×10^{14} Hz ?

A. When Cs is placed inside a vacuum chamber with an ammeter connected to it and yellow light is focused on Cs , the ammeter shows the presence of current.

B. When the brightness of the yellow light is dimmed, the value of the current in the ammeter is reduced.

C. When a red light is used instead of the yellow light, the current produced is higher with respect to the yellow light.

D. When a blue light is used, the ammeter shows the formation of current.

E. When a white light is used. the ammeter shows formation of current.

Choose the correct answer from the options given below:

JEE Main 2025 (Online) 7th April Morning Shift

Options:

A. B, C and D Only

B. A, C, D and E Only

C. A, B, D and E Only

D. A, D and E Only

Answer: C

Solution:

To determine the correct statements regarding the threshold frequency of cesium, first note that the threshold frequency given is 5.16×10^{14} Hz. Using this frequency, we can calculate the corresponding wavelength, λ, using the equation:

$\lambda = \frac{c}{v} = \frac{3 \times 10^8 \text{ m/s}}{5.16 \times 10^{14} \text{ Hz}}$

This calculation gives $\lambda \approx 581.39$ nm.

Key points:

The wavelength calculated is near the yellow light region. Therefore, yellow light has enough energy to cause a photoelectric effect.

When the intensity of light (brightness) decreases, the photocurrent will also decrease, as fewer photons are available to eject electrons.

Red light, with its larger wavelength and lower frequency, does not have enough energy to cause the photoelectric effect in cesium.

Blue light has a higher frequency than yellow light ($v_{\text{blue}} > v_{\text{yellow}}$), meaning it can produce a photoelectric current.

White light includes all visible frequencies, including those above the threshold, so it will also emit a current.

Thus, the correct statements involve using yellow, blue, and white light, without producing an effect with red light:

A: Yellow light produces a current.

B: Dimming yellow light reduces the current.

D: Blue light produces a current.

E: White light produces a current.

Therefore, the correct statements are A, B, D, and E.

Question20

The extra stability of half-filled subshell is due to :

(A) Symmetrical distribution of electrons

(B) Smaller coulombic repulsion energy

(C) The presence of electrons with the same spin in non-degenerate orbitals

(D) Larger exchange energy

(E) Relatively smaller shielding of electrons by one another

Indentify the correct statements :

JEE Main 2025 (Online) 7th April Evening Shift

Options:

A. (B), (D) and (E) only

B. (A), (B), (D) and (E) only

C. (B), (C) and (D) only

D. (A), (B) and (D) only

Answer: B

Solution:

The enhanced stability of a half-filled subshell is attributed to the following factors:

Symmetrical Distribution of Electrons: Electrons are evenly distributed across the available orbitals, leading to a balanced and stable arrangement.

Large Exchange Energy: The energy due to the exchange of electrons with parallel spins among degenerate orbitals is maximized, contributing to increased stability.

Smaller Coulombic Repulsion: The repulsion between electrons is minimized in a half-filled configuration, reducing the overall energy of the subshell.

Smaller Shielding of Electrons: In a half-filled subshell, electrons are more exposed to the nuclear charge, as there is less shielding effect from other electrons, enhancing stability.

Question21

Correct statements for an element with atomic number 9 are:

A. There can be 5 electrons for which $m_s = +\frac{1}{2}$ and 4 electrons for which $m_s = -\frac{1}{2}$.

B. There is only one electron in p_z orbital.

C. The last electron goes to orbital with $n = 2$ and $l = 1$.

D. The sum of angular nodes of all the atomic orbitals is 1.

Choose the correct answer from the options given below:

JEE Main 2025 (Online) 8th April Evening Shift

Options:

A.

A and B Only

B.

A, C and D Only

C.

A and C Only

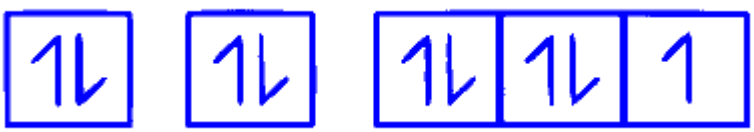
D.

C and D Only

Answer: C

Solution:

Element with atomic number 9 is Fluorine
$F(9) = 1s^2 2s^2 2p^5$



(A) 5 electrons can be up-spin $\left[\mathrm{m_s} = +\frac{1}{2}\right]$ and 4 electrons can be down spin $\left[\mathrm{m_s} = -\frac{1}{2}\right]$

(B) Unpaired electron can be in anyone of p_x, p_y or p_z orbital

(C) Last electron is in 2 p subshell with $n = 2, \ell = 1$

(D) Angular node for s-orbital $= 0$ while of each p -orbital $= 1$

Sum of all angular node $= 3$

Question22

Which of the following electronic configuration would be associated with the highest magnetic moment?

[27-Jan-2024 Shift 1]

Options:

A.

[Ar]$3d^7$

B.

[Ar]$3d^8$

C.

[Ar]$3d^3$

D.

[Ar]$3d^6$

Answer: D

Solution:

	$3d^7$	$3d^8$	$3d^3$	$3d^6$
No.of. unpaired e^-	3	2	3	4
Spin only Magnetic moment	$\sqrt{15}$ BM	$\sqrt{8}$ BM	$\sqrt{15}$ BM	$\sqrt{24}$ BM

Question23

Consider the following complex ions

$P = [FeF_6]^{3-}$

$Q = [V(H_2O)_6]^{2+}$

$R = [Fe(H_2O)_6]^{2+}$

The correct order of the complex ions, according to their spin only magnetic moment values (in B.M.) is :

[27-Jan-2024 Shift 1]

Options:

A.

R < Q < P

B.

R < P < Q

C.

Q < R < P

D.

Q < P < R

Answer: C

Solution:

$[FeF_6]^{3-} : Fe^{+3} : [Ar]3d^5$

1	1	1	1	1

F : Weak field Ligand

No. of unpaired electron's $= 5$

$\mu = \sqrt{5(5+2)}$

$\mu = \sqrt{35}\,BM$

$[V(H_2O)_6]^{+2} : V^{+2} : 3d^3$

1	1	1		

No. of unpaired electron's $= 3$

$\mu = \sqrt{3(3+2)}$

$\mu = \sqrt{15}\,BM$

$[Fe(H_2O)_6]^{+2} : Fe^{+2} : 3d^6$

1↓	1	1	1	1

H_2O : Weak field Ligand

No. of unpaired electron's $= 4$

No. of unpaired electron's $= 4$

$\mu = \sqrt{4(4+2)}$

$\mu = \sqrt{24}\,BM$

Question24

The electronic configuration for Neodymium is: [Atomic Number for Neodymium 60]

[27-Jan-2024 Shift 1]

Options:

A.

$[Xe]4f^4 6\ s^2$

B.

$[Xe]5f^4 7\ s^2$

C.

$[Xe]4f^6 6\ s^2$

D.

$[Xe]4f^1 5d^1 6\ s^2$

Answer: A

Solution:

Electronic configuration of $Nd(Z = 60)$ is;

$[Xe]4f^4 6\ s^2$

Question25

The number of electrons present in all the completely filled subshells having n = 4 and s = + 1/2 is_____

(Where n = principal quantum number and s= spin quantum number)

[27-Jan-2024 Shift 1]

Answer: 16

Solution:

$n = 4$ can have,

	4s	4p	4d	4f
Total e^-	2	6	10	14
Total e^- with $S = +\frac{1}{2}$	1	3	5	7

So, Ans. 16

Question26

Total number of ions from the following with noble gas configuration is_____

$Sr^{2+}(Z = 38)$, $Cs^{+}(Z = 55)$, $La^{2+}(Z = 57)Pb^{2+}$

$(Z = 82)$, $Yb^{2+}(Z = 70)$ and $Fe^{2+}(Z = 26)$

[27-Jan-2024 Shift 2]

Answer: 2

Solution:

Noble gas configuration $= ns^2np^6$

$[Sr^{2+}] = [Kr]$

$[Cs^{+}] = [Xe]$

$[Yb^{2+}] = [Xe]4f^{14}$

$[La^{2+}] = [Xe]5d^{1}$

$[Pb^{2+}] = [Xe]4f^{14}5d^{10}6s^{2}$

$[Fe^{2+}] = [Ar]3d^{6}$

Question27

The correct set of four quantum numbers for the valence electron of rubidium atom (Z = 37) is:

[29-Jan-2024 Shift 1]

Options:

A.

5, 0, 0, + 1/2

B.

5, 0, 1, + 1/2

C.

5, 1, 0, + 1/2

D.

5, 1, 1, + 1/2

Answer: A

Solution:

$\mathrm{Rb} = [\mathrm{Kr}]5\,s^1$

$\mathrm{n} = 5$

$l = 0$

$\mathrm{m} = 0$

$s = +1/2 \text{ or } -1/2$

Question28

Choose the correct answer from the options given below :-

	List I (Spectral Series for Hydrogen)		List II (Spectral Region Higher
A.	Lyman	I.	Infrared region
B.	Balmer	II.	UV region
C.	Paschen	III.	Infrared region
D.	Pfund	IV.	Visible region

[29-Jan-2024 Shift 2]

Options:

A.

A-II, B-III, C-I, D-IV

B.

A-I, B-III, C-II, D-IV

C.

A-II, B-IV, C-III, D-I

D.

A-I, B-II, C-III, D-IV

Answer: C

Solution:

A - II, B - IV, C - III, D - I

Fact based.

Question29

Given below are two statements:

Statement-I: The orbitals having same energy are called as degenerate orbitals.
Statement-II: In hydrogen atom, 3p and 3d orbitals are not degenerate orbitals.

In the light of the above statements, choose the most appropriate answer from the options given

[30-Jan-2024 Shift 1]

Options:

A.

Statement-I is true but Statement-II is false

B.

Both Statement-I and Statement-II are true.

C.

Both Statement-I and Statement-II are false

D.

Statement-I is false but Statement-II is true

Answer: A

Solution:

For single electron species the energy depends upon principal quantum number ' n ' only. So, statement II is false.

Statement I is correct definition of degenerate orbitals.

Question30

Number of spectral lines obtained in He+spectra, when an electron makes transition from fifth excited state to first excited state will be___

[30-Jan-2024 Shift 2]

Answer: 10

Solution:

5^{th} excited state $\Rightarrow n_1 = 6$

1^{st} excited state $\Rightarrow n_2 = 2$

$\Delta n = n_1 - n_2 = 6 - 2 = 4$

Maximum number of spectral lines

$= \frac{\Delta n(\Delta n + 1)}{2} = \frac{4(4+1)}{2} = 10$

Question31

The ionization energy of sodium in $kJmol^{-1}$. If electromagnetic radiation of wavelength 242 nm is just sufficient to ionize sodium atom is___

[31-Jan-2024 Shift 1]

Answer: 494

Solution:

$E = \frac{1240}{\lambda(nm)} eV$

$= \frac{1240}{242} eV$

$= 5.12\,eV$

$= 5.12 \times 1.6 \times 10^{-19}$

$= 8.198 \times 10^{-19} J/\ atom$

$= 494\,kJ/mol$

Question32

The four quantum numbers for the electron in the outer most orbital of potassium (atomic no. 19) are

[31-Jan-2024 Shift 2]

Options:

A.

$n = 4, l = 2, m = -1, s = +1/2$

B.

$n = 4, l = 0, m = 0, s = +1/2$

C.

$n = 3, l = 0, m = 1, s = +1/2$

D.

$n = 2, l = 0, m = 0, s = +1/2$

Answer: B

Solution:

$_{19}K$ $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1$.

Outermost orbital of potassium is 4 s orbital

$n = 4, l = 0, m_l = 0, s = \pm \frac{1}{2}$.

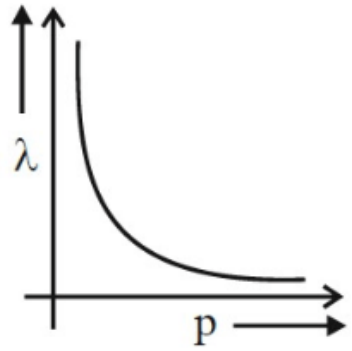
Question33

According to the wave-particle duality of matter by de-Broglie, which of the following graph plot presents most appropriate relationship between wavelength of electron (λ) and momentum of electron (p) ?

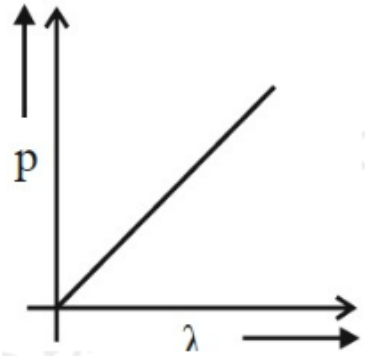
[1-Feb-2024 Shift 1]

Options:

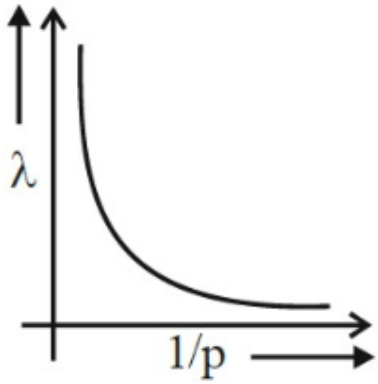
A.



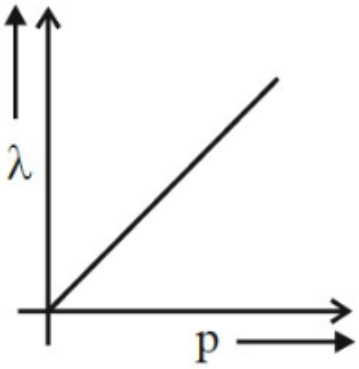
B.



C.



D.



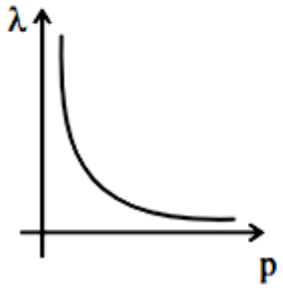
Answer: A

Solution:

$\lambda = \frac{h}{p}\left[\lambda \propto \frac{1}{p}\right]$

$\Rightarrow \lambda p = h(\text{ constant })$

So, the plot is a rectangular hyperbola



Question34

The number of radial node/s for 3p orbital is:

[1-Feb-2024 Shift 2]

Options:

A.

1

B.

4

C.

2

D.

3

Answer: A

Solution:

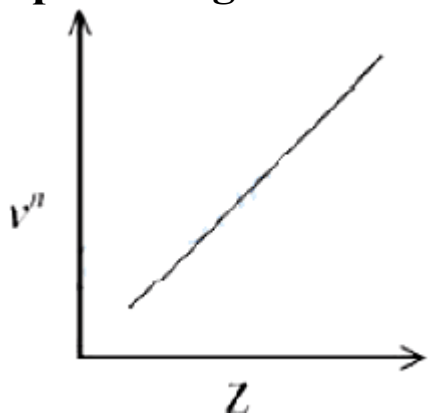
For $3p : n = 3, \ell = 1$

Number of radial node $= n - \ell - 1$

$= 3 - 1 - 1 = 1$

Question35

It is observed that characteristic X-ray spectra of elements show regularity. When frequency to the power 'n' i.e. v^n of X-rays emitted is plotted against atomic number ' Z ', following graph is obtained.



The value of ' n ' is
[24-Jan-2023 Shift 1]

Options:

A. 1

B. 2

C. $\frac{1}{2}$

D. 3

Answer: C

Solution:

Solution:
According to Henry Moseley $\sqrt{\nu}\alpha z - b$
So $n = \frac{1}{2}$

Question36

If wavelength of the first line of the Paschen series of hydrogen atom is 720 nm, then the wavelength of the second line of this series is _____nm
(Nearest integer)
[24-Jan-2023 Shift 1]

Answer: 492

Solution:

Solution:

$$\frac{1}{(\lambda_1)_P} = R_H Z^2 \left(\frac{1}{9} - \frac{1}{16}\right)$$

$$\frac{1}{(\lambda_2)_P} = R_H Z^2 \left(\frac{1}{9} - \frac{1}{25}\right)$$

$$\frac{(\lambda_2)_P}{(\lambda_1)_P} = \frac{\frac{7}{16 \times 9}}{\frac{16}{25 \times 9}} = \frac{25 \times 7}{16 \times 16}$$

$$(\lambda_2)_P = \frac{25 \times 7}{16 \times 16} \times 720$$

$$(\lambda_2)_P = 492 \text{ nm}$$

Question37

The number of s-electrons present in an ion with 55 protons in its unipositive state is
[24-Jan-2023 Shift 2]

Options:

A. 8

B. 9

C. 12

D. 10

Answer: D

Solution:

Solution:
$Z = 55[Cs] \Rightarrow [Xe]6\ s^1$
$[Cs^+] \Rightarrow [Xe]$ i.e. upto 5 s count e^- of s-subshell
i.e. 1 s, 2 s, 3 s, 4 s, 5 s $\Rightarrow$ 10 electrons

Question38

The radius of the 2 nd orbit of Li^{2+} is x. The expected radius of the 3 rd orbit of Be^{3+} is
[25-Jan-2023 Shift 1]

Options:

A. $\frac{9}{4}x$

B. $\frac{4}{9}x$

C. $\frac{27}{16}x$

D. $\frac{16}{27}x$

Answer: C

Solution:

Solution:

Li^{2+}

$r_2 = x = k \times \frac{2^2}{3} = \frac{4k}{2}$

$\frac{y}{x} = \frac{9}{4} \times \frac{3}{4} = \frac{27}{16}$

$y = \frac{27}{16}x$

Be^{3+}

$r_3 = y = k \times \frac{3^2}{4}$

Question39

How many of the following metal ions have similar value of spin only magnetic moment in gaseous state?_____
(Given: Atomic number: V, 23; Cr, 24; Fe, 26; Ni, 28)
$V^{3+} \cdot Cr^{3+}, Fe^{2+}, Ni^{3+}$
[25-Jan-2023 Shift 1]

Answer: 2

Solution:

Solution:

$\mu_s = \sqrt{n(n+2)}BM$ (n = no. of unpaired electrons)

V^{3+} : $[Ar]3d^2 4s^0$ 2

Cr^{3+} : $[Ar]3d^3 4s^0$ 3

Fe^{2+} : $[Ar]3d^6 4s^0$ 4

Ni^{3+} : $[Ar]3d^7 4s^0$ 3

Cr^{3+} & Ni^{3+} have same value of μ_s

Question40

The shortest wavelength of hydrogen atom in Lyman series is λ. The longest wavelength in Balmer series of $He^+$is
[29-Jan-2023 Shift 1]

Options:

A. $\frac{5}{9\lambda}$

B. $\frac{9\lambda}{5}$

C. $\frac{36\lambda}{5}$

D. $\frac{5\lambda}{9}$

Answer: B

Solution:

Solution:

For H : $\frac{1}{\lambda} = R_H \times 1^2 \left(\frac{1}{1^2} - \frac{1}{\infty^2} \right)$ . . . (1)

$\frac{1}{\lambda_{He^+}} = R_H \times 2^2 \times \left(\frac{1}{4} - \frac{1}{9} \right)$ . . . (2)

From (1) & (2) $\frac{\lambda_{He^+}}{\lambda} = \frac{9}{5}$

$\lambda_{He^+} = \lambda \times \frac{9}{5}$

$\lambda_{He^+} = \frac{9\lambda}{5}$

Question41

Assume that the radius of the first Bohr orbit of hydrogen atom is 0.6Å. The radius of the third Bohr orbit of $He^+$is _____ picometer. (Nearest Integer)
[29-Jan-2023 Shift 2]

Answer: 270

Solution:

Solution:

$r \propto \frac{n^2}{Z}$

$r_{He^+} = r_H \times \frac{n^2}{Z}$

$r_{He^+} = 0.6 \times \frac{(3)^2}{2}$

$= 2.7Å$

$r_{He^+} = 270\,pm$

Question42

The energy of one mole of photons of radiation of frequency 2×10^{12} Hz in $Jmol^{-1}$ is _____.
(Nearest integer)
(Given: $h = 6.626 \times 10^{-34}$ Js
$N_A = 6.022 \times 10^{23} mol^{-1}$)
[30-Jan-2023 Shift 1]

Answer: 798

Solution:

Solution:
For one photon $E = hv$
For one mole photon,

$E = 6.023 \times 10^{23} \times 6.626 \times 10^{-34} \times 2 \times 10^{12}$

$= 798.16J$

$\approx 798J$

Question43

Maximum number of electrons that can be accommodated in shell with n = 4 are:
[30-Jan-2023 Shift 2]

Options:

A. 16

B. 32

C. 50

D. 72

Answer: B

Solution:

Solution:
The number of electrons in the orbitals of sub-shell of $n = 4$ are

4s	2
4p	6
4d	10
4f	14
(Total)	32

Question44

The wave function (Ψ) of 2 s is given by

$$\Psi_{2s} = \frac{1}{2\sqrt{2\pi}}\left(\frac{1}{a_0}\right)^{1/2}\left(2-\frac{r}{a_0}\right)e^{-r/2a_0}$$

At $r = r_0$, radial node is formed. Thus, r_0 in terms of a_0
[30-Jan-2023 Shift 2]

Options:

A. $r_0 = a_0$

B. $r_0 = 4a_0$

C. $r_0 = \frac{a_0}{2}$

D. $r_0 = 2a_0$

Answer: D

Solution:

Solution:
At node $\Psi_{2s} = 0$

$\therefore 2 - \frac{r_0}{a_0} = 0$

$\therefore r_0 = 2a_0$

Question45

Which transition in the hydrogen spectrum would have the same wavelength as the Balmer type transition from n = 4 to n = 2 of He^+spectrum
[31-Jan-2023 Shift 1]

Options:

A. n = 2 to n = 1

B. n = 1 to n = 3

C. n = 1 to n = 2

D. n = 3 to n = 4

Answer: A

Solution:

Solution:

He^+ ion:

$$\frac{1}{\lambda(H)} = R(1)^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$\frac{1}{\lambda(He^+)} = R(2)^2\left[\frac{1}{2^2} - \frac{1}{4^2}\right]$$

Given $\lambda(H) = \lambda(He^+)$

$$R(1)^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] = R(4)\left[\frac{1}{2^2} - \frac{1}{4^2}\right]$$

$$\frac{1}{n_1^2} - \frac{1}{n_2^2} = \frac{1}{1^2} - \frac{1}{2^2}$$

On comparing $n_1 = 1 \& n_2 = 2$

Ans. 1

Question46

Arrange the following orbitals in decreasing order of energy ?
(A) n = 3, 1 = 0, m = 0
(B) n = 4, 1 = 0, m = 0
(C) n = 3, 1 = 1, m = 0
(D) n = 3, l = 2, m = 1
The correct option for the order is :
[31-Jan-2023 Shift 2]

Options:

A. B > D > C > A

B. D > B > C > A

C. A > C > B > D

D. D > B > A > C

Answer: B

Solution:

Solution:
(A) n = 3; l = 0; m = 0; 3 s orbital
(B) n = 4; 1 = 0; m = 0; 4 s orbital
(C) n = 3; 1 = 1; m = 0; 3p orbital
(D) n = 3; 1 = 2; m = 0; 3d orbital

As per Hund's rule energy is given by $(n+l)$ value.
If value of $(n+l)$ remains same then energy is given by n only.

Question47

Electrons in a cathode ray tube have been emitted with a velocity of $1000 ms^{-1}$. The number of following statements which is/are true about the emitted radiation is _____.
Given : $h = 6 \times 10^{-34}$ Js, $m_e = 9 \times 10^{-31}$ kg.

(A) The deBroglie wavelength of the electron emitted is 666.67 nm.
(B) The characteristic of electrons emitted depend upon the material of the electrodes of the cathode ray tube.
(C) The cathode rays start from cathode and move towards anode.
(D) The nature of the emitted electrons depends on the nature of the gas present in cathode ray tube.
[1-Feb-2023 Shift 1]

Answer: 2

Solution:

Solution:
(A) $V_e = 1000 m/s$; $h = 6 \times 10^{-34}$ Js;

$m_e = 9 \times 10^{-31}$ kg

$$\lambda = \frac{h}{mv} = \frac{6 \times 10^{-34}}{9 \times 10^{-31} \times 1000} = 666.67 \times 10^{-9} m$$

$= 666.67$ nm
(B) The characteristic of electrons emitted is independent of the material of the electrodes of the cathode ray tube.
(C) The cathode rays start from cathode and move towards anode.
(D) The nature of the emitted electrons is independent on the nature of the gas present in cathode ray tube.

Question48

Which one of the following sets of ions represents a collection of isoelectronic species?
(Given : Atomic Number: F : 9, Cl : 17, Na = 11,
Mg = 12, Al = 13, K = 19, Ca = 20, Sc = 21)
[1-Feb-2023 Shift 2]

Options:

A. (Li^{+}, Na^{+}, Mg^{2+}, Ca^{2+}.

B. Ba^{2+}, Sr^{2+}, K+, Ca^{2+}

C. CN^{3-}, O^{2-}, F^{-}, S^{2-}

D. (K^{+}, Cl^{-}, Ca^{2+}, Sc^{3+}.

Answer: D

Solution:

Solution:
K^{+} Cl^{1} Ca^{2+} Sc^{3+}
18 18 18 18

Question49

The wavelength of an electron of kinetic energy 4.50×10^{-29}J is ..... $\times 10^{-5}$m. (Nearest integer)
Given : mass of electron is 9×10^{-31} kg, h = 6.6×10^{-34}J s
[6-Apr-2023 shift 1]

Answer: 7

Solution:

Solution:

$$\lambda_d = \frac{h}{mv} = \frac{h}{\sqrt{2\,mKE}} = \frac{6.6\times10^{-34}}{\sqrt{2\times9\times10^{-31}\times4.5\times10^{-29}}}$$

$$= \frac{6.6\times10^{-34}}{\sqrt{9^2\times10^{-60}}}$$

$$= \frac{6.6\times10^{-34}}{9\times10^{-30}} = \frac{6.6}{9}\times10^{-4}$$

$$= 7.3\times10^{-5}\text{m}$$

Therefore Ans = 7

Question50

If the radius of the first orbit of hydrogen atom a_0, then de Broglie's wavelength of electron in 3 rd orbit is [6-Apr-2023 shift 2]

Options:

A. $\frac{\pi a_0}{6}$

B. $\frac{\pi a_0}{3}$

C. $6\pi a_0$

D. $3\pi a_0$

Answer: C

Solution:

Solution:

$$(r_3)_H = \frac{a_0 n^2}{Z} = a_0\times3^2 = 9a_0$$

$2\pi r = n\lambda$

$\Rightarrow 2\pi\times9a_0 = 3\lambda$

$\Rightarrow \lambda = 6\pi a_0$

Question51

The number of following statements which is/are incorrect is _____

[8-Apr-2023 shift 1]

Options:

A. Line emission spectra are used to study the electronic structure

B. The emission spectra of atoms in the gas phase show a continuous spread of wavelength from red to violet

C. An absorption spectrum is like the photographic negative of an emission spectrum

D. The element helium was discovered in the sun by spectroscopic method

Answer: A

Solution:

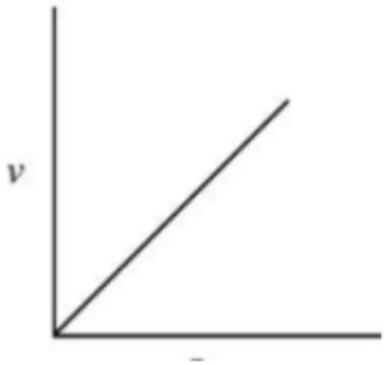
Solution:
Fact

Question52

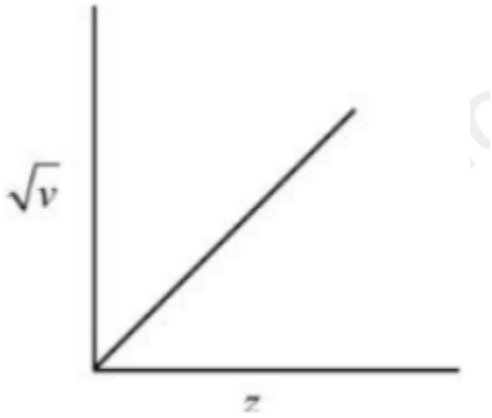
Henry Moseley studied characteristic X-ray spectra of elements. The graph which represents his observation correctly is
Given v = frequency of X-ray emitted
Z = atomic number
[8-Apr-2023 shift 2]

Options:

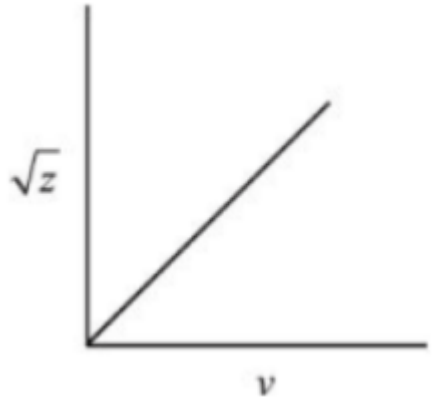
A.



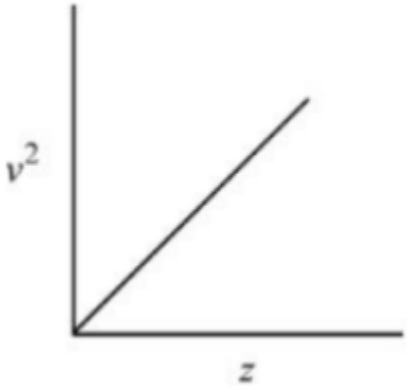
B.



C.



D.



Answer: B

Solution:

Solution:
$\sqrt{v} \alpha Z$

Question53

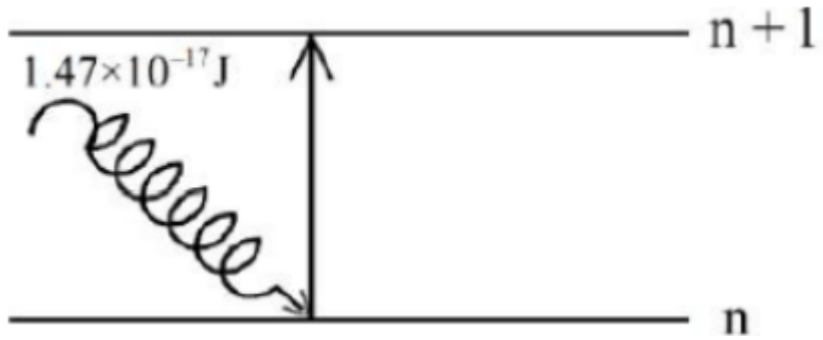
The number of atomic orbitals from the following having 5 radial nodes is _____ 7 s, 7p, 6 s, 8p, 8d
[8-Apr-2023 shift 2]

Answer: 3

Solution:

Solution:
No. of radial node
$= n - \ell - 1$
For $6S \rightarrow 6 - 0 - 1 = 5$
$7P \rightarrow 7 - 1 - 1 = 5$
$8d \rightarrow 8 - 2 - 1 = 5$

Question54



The electron in the nth orbit of Li^{2+} is excited to (n + 1) orbit using the radiation of energy 1.47×10^{-17}J(as shown in the diagram). The value of n is _____
Given: $R_H = 2.18 \times 10^{-18}$J
[10-Apr-2023 shift 2]

Answer: 1

Solution:

Solution:

$$\Delta E = R_H Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

$$1.47 \times 10^{-17} = 2.18 \times 10^{-18} \times 9 \left(\frac{1}{n^2} - \frac{1}{(n+1)^2} \right)$$

$$\frac{1.47}{1.96} = \frac{3}{4} = \frac{1}{n^2} - \frac{1}{(n+1)^2}$$

So, $n = 1$

Question55

For a metal ion, the calculated magnetic moment is 4.90 BM. This metal ion has _____ number of unpaired electrons.
[10-Apr-2023 shift 2]

Answer: 4

Solution:

Solution:

$\mu = 4.90\,\text{BM}.$

$\mu = \sqrt{n(n+2)}$

So, $n = 4$

Question56

Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R:
Assertion A : In the photoelectric effect electrons are ejected from the metal surface as soon as the beam of light of frequency greater than threshold frequency strikes the surface.
Reason R: When the photon of any energy strikes an electron in the atom transfer of energy from the photon to the electron takes place.
In the light of the above statements, choose the most appropriate answer from the options given below:
[11-Apr-2023 shift 1]

Options:

A. A is correct but R is not correct

B. A is not correct but R is correct

C. Both A and R correct and R is the correct explanation of A

D. Both A and R are correct but R is NOT the correct explanation of A

Answer: A

Solution:

Solution:
Assertion A is correct but Reason is not correct.

Question57

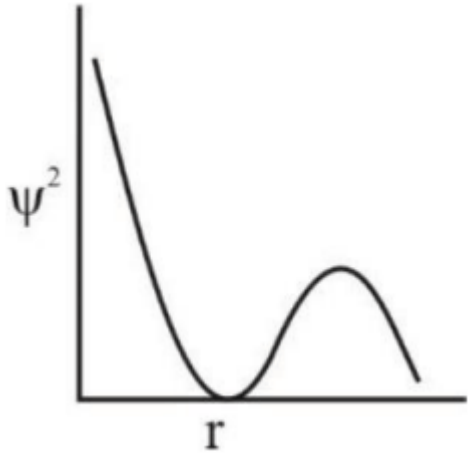
The number of correct statements from the following is
A. For 1 s orbital, the probability density is maximum at the nucleus
B. For 2 s orbital, the probability density first increases to maximum and then decreases sharply to zero.
C. Boundary surface diagrams of the orbitals encloses a region of 100% probability of finding the electron.
D. p and d-orbitals have 1 and 2 angular nodes respectively
E. probability density of p-orbital is zero at the nucleus
[11-Apr-2023 shift 2]

Answer: 3

Solution:

Solution:

A, D and E statements are correct.



For 2 s orbital, the probability density first decreases and then increases.
At any distance from nucleus the probability density of finding electron is never zero and it always have some finite value.

Question58

Given below are two statement: one is labelled as Assertion A and the other is labelled as Reason R
Assertion A: 5f electrons can participate in bonding to a far greater extent than 4f electrons
Reason R: 5f orbitals are not as buried as 4f orbitals In the light of the above statements,
choose the correct answer from the options given below
[12-Apr-2023 shift 1]

Options:

A. Both A and R are true and R is the correct explanation of A

B. Both A and R are true but R is NOT the correct explanation of A

C. A is true but R is false

D. A is false but R is true

Answer: A

Solution:

Solution:
Due to this reason actinoids participate in more bonding.

Question59

Values of work function (W_0) for a few metals are gives below

Metal	Li	Na	K	Mg	Cu	Ag
W_0 / eV	2.42	2.3	2.25	3.7	4.8	4.3

The number of metals which will show photoelectric effect when light of wavelength 400 nm falls on it is

Given: $h = 6.6 \times 10^{-34}$ J s

$c = 3 \times 10^{8} ms^{-1}$

$e = 1.6 \times 10^{-19}$ C

[12-Apr-2023 shift 1]

Answer: 3

Solution:

Solution:

$E(ev) = \frac{1240}{400} = 3.1$ ev

Mg, Cu, Ag

Question60

The energy of an electron in the first Bohr orbit of hydrogen atom is -2.18×10^{-18} J. Its energy in the third Bohr orbit is _____.

[13-Apr-2023 shift 1]

Options:

A. $\frac{1}{27}$ of this value

B. $\frac{1}{9}$ th of this value

C. One third of this value

D. Three times of this value

Answer: B

Solution:

Solution:

$E_{1,1} = -2.18 \times 10^{-18} J$

$E_{3,1} = E_{1,1} \times \frac{1^2}{3^2}$

$E_{3,1} = \frac{1}{9} \times E_{1,1}$

Question61

The orbital angular momentum of an electron in 3 s orbital is $\frac{xh}{2\pi}$. The value of x is _____ (nearest integer)
[13-Apr-2023 shift 2]

Answer: 0

Solution:

Solution:

Orbital angular momentum $= \sqrt{1(1+1)}\ \frac{h}{2\pi}$

Value of 1 for $s = 0$

Question62

The total number of isoelectronic species from the given set is _____.
O^{2-}, F^{-}, Al, Mg^{2+}, Na^{+}, O^{+}, Mg, Al^{3+}, F
[15-Apr-2023 shift 1]

Answer: 5

Solution:

Solution:

O^{-2},	F^{-}	mg^{+2}	Na^{+1}	Al^{+3}	Isoelectronic species
$10e^{-}$	$10e^{-}$	$10e^{-}$	$10e^{-}$	$10e^{-}$	

Question63

Consider the following pairs of electrons
(A)
(a)$n = 3, l = 1, m_1 = 1, m_s = +\frac{1}{2}$
(b) $n = 3, l = 2, m_1 = 1, m_s = +\frac{1}{2}$
(B)
(a) $n = 3, l = 2, m_1 = -2, m_s = -\frac{1}{2}$
(b) $n = 3, l = 2, m_1 = -1, m_s = -\frac{1}{2}$
(C)
(a)$n = 4, l = 2, m_1 = 2, m_s = +\frac{1}{2}$
(b) $n = 3, l = 2, m_1 = 2, m_s = +\frac{1}{2}$
The pairs of electrons present in degenerate orbitals is/are :
[24-Jun-2022-Shift-1]

Options:

A. Only (A)

B. Only (B)

C. Only (C)

D. (B) and (C)

Answer: B

Solution:

Solution:
For degenerate orbitals, only the value of m must be different.
The value of $(n+1)$ must be the same.Hence, the pair of electrons with quantum numbers given in (B) are degenerate.

Question64

The energy of one mole of photons of radiation of wavelength 300nm is

(Given : $h = 6.63 \times 10^{-34}$ J s, $N_A = 6.02 \times 10^{23} mol^{-1}$, $c = 3 \times 10^8 ms^{-1}$)

[24-Jun-2022-Shift-2]

Options:

A. $235 kJ\ mol^{-1}$

B. $325 kJ\ mol^{-1}$

C. $399 kJ\ mol^{-1}$

D. $435 kJ\ mol^{-1}$

Answer: C

Solution:

Solution:
Energy of one photon

$$E = \frac{1240}{\lambda(nm)} eV$$

$$= \frac{1240}{300}$$

$$= 4.1333\ eV$$

$\therefore$ Energy of one mole of photon

$= 4.1333 \times 6.02 \times 10^{23}\,\text{eV}$

$= 4.1333 \times 6.02 \times 10^{23} \times 1.6 \times 10^{-19}\text{J}$

$= \dfrac{4.1333 \times 6.02 \times 10^{23} \times 1.6 \times 10^{-19}}{1000}\,\text{kJ}$

$= 399\,\text{kJ/mol}$

Question65

The pair, in which ions are isoelectronic with Al^{3+} is : [25-Jun-2022-Shift-1]

Options:

A. $Br^{-}$and Be^{2+}

B. $Cl^{-}$and Li^{+}

C. S^{2-} and K^{+}

D. O^{2-} and Mg^{2+}

Answer: D

Solution:

Solution:
O^{2-}, Mg^{2+} and Al^{3+} are isoelectronic. All have 10 electrons.

Question66

The longest wavelength of light that can be used for the ionisation of lithium atom (Li) in its ground state is $x \times 10^{-8}$m. The value of x is___ (Nearest Integer). (Given : Energy of the electron in the first shell of the hydrogen atom is -2.2×10^{-18}J; h = 6.63×10^{-34} Js and c = $3 \times 10^{8}\text{ms}^{-1}$) [25-Jun-2022-Shift-1]

Answer: 4

Solution:

Solution:
Bohr model is not valid for lithium atom (Li) as Bohr model is valid for only single electronic species, so it would be valid for Li^{+2} but not Li atom.

Question67

The minimum energy that must be possessed by photons in order to produce the photoelectric effect with platinum metal is :
[Given: The threshold frequency of platinum is $1.3 \times 10^{15} s^{-1}$ and $h = 6.6 \times 10^{-34} Js$.]
[25-Jun-2022-Shift-2]

Options:

A. $3.21 \times 10^{-14} J$

B. $6.24 \times 10^{-16} J$

C. $8.58 \times 10^{-19} J$

D. $9.76 \times 10^{-20} J$

Answer: C

Solution:

Solution:
The minimum energy possessed by photons will be equal to the work function of the metal.
$\therefore E_{min} = h\nu_0 J$
$= 6.6 \times 10^{-34} \times 1.3 \times 10^{15}$
$= 8.58 \times 10^{-19} J$

Question68

If the radius of the 3 rd Bohr's orbit of hydrogen atom is r_3 and the radius of 4 th Bohr's orbit is r_4. Then :
[26-Jun-2022-Shift-1]

Options:

A. $r_4 = \frac{9}{16}r_3$

B. $r_4 = \frac{16}{9}r_3$

C. $r_4 = \frac{3}{4}r_3$

D. $r_4 = \frac{4}{3}r_3$

Answer: B

Solution:

Solution:
We know,
$r = r_0 \times \frac{n^2}{z}$
For hydrogen atom,
$\therefore r_3 = r_0 \times \frac{3^2}{1}$
$\Rightarrow r_0 \times \frac{r_3}{9}$
and $r_4 = r_0 \times \frac{4^2}{1}$
$= \frac{r_3}{9} \times 16$
$= \frac{16}{9}r_3$

Question69

The number of radial and angular nodes in 4d orbital are, respectively
[26-Jun-2022-Shift-2]

Options:

A. 1 and 2

B. 3 and 2

C. 1 and 0

D. 2 and 1

Answer: A

Solution:

Solution:
We know,
Radial nodes $= n - l - 1$
and Angular nodes $= 1$
For 4d orbital,
$n = 4$
$I = 2$
$\therefore$ Radial nodes $= 4 - 2 - 1 = 1$
Angular nodes $= 2$

Question70

If the uncertainty in velocity and position of a minute particle in space are, $2.4 \times 10^{-26}(ms^{-1})$ and $10^{-7}(m)$ respectively. The mass of the particle in g is____ (Nearest integer)
(Given : $h = 6.626 \times 10^{-34}$ Js)
[27-Jun-2022-Shift-1]

Answer: 22

Solution:

Solution:
We know from hisenberg uncertainty principle
$\Delta x \cdot \Delta p = \frac{h}{4\pi}$
$\Rightarrow \Delta x \cdot m \Delta v = \frac{h}{4\pi}$
Given,

$\Delta x = 10^{-7} m$
$\Delta x = 2.4 \times 10^{-26} m/s$
$h = 6.626 \times 10^{-34} Js$
$\therefore 10^{-7} \times m \times 2.4 \times 10^{-26} = \frac{6.626 \times 10^{-34}}{4\pi}$
$\Rightarrow 2.4m = \frac{6.626}{4\pi \times 10}$
$\Rightarrow m = 0.022\ kg$
$\Rightarrow m = 22\ gm$

Question71

Consider the following set of quantum numbers.

	n	1	m_1
A.	3	3	3
B.	3	2	2
C.	2	1	+1
D.	2	2	+2

The number of correct sets of quantum numbers is _____. [27-Jun-2022-Shift-2]

Answer: 2

Solution:

Solution:
For A,
Given $n = 3$ and $l = 3$
but we know maximum value of $l = n - 1$.
$\therefore$ l can't be equal to n.
So, Set A of quantum numbers is not possible.
For B,
Given $n = 3, l = 2, m = -2$
Here, $l = 2$ which follow the rule $l = n - 1$.
And we know possible value of m is $-l$ to $+l$.

here possible value of $m = -2$ to $+2$
$\therefore$ This Set B is valid set of quantum numbers.
For C,
Given $n = 2, I = 1, m = +1$
Here $I = 1$ which follows the rule $I = n - 1$.
For $I = 1$ possible value of $m = -1$ to $+1$
Here $m = +1$. So value of m is valid.
$\therefore$ Set C is valid set of quantum numbers.
For D,
Given $n = 2, I = 2, m = +2$
$I = 2$ does not follow the rule $I = n - 1$ rule.
$\therefore$ Set D is not valid set of quantum numbers.

Question72

If the work function of a metal is 6.63×10^{-19}J, the maximum wavelength of the photon required to remove a photoelectron from the metal is___ nm. (Nearest integer)

[Given : $h = 6.63 \times 10^{-34}$Js, and $c = 3 \times 10^{8}ms^{-1}$]

[28-Jun-2022-Shift-1]

Answer: 300

Solution:

Solution:
Given,

$$\text{Work function} = 6.63 \times 10^{-19}\text{J}$$

$$= \frac{6.63 \times 10^{-19}}{1.6 \times 10^{-19}}$$

$$= 4.14\,\text{eV}$$

We know,

$$E = \frac{1240}{\lambda(\text{nm})}$$

$$\Rightarrow 4.14 = \frac{1240}{\lambda}$$

$$\lambda = 300\,\text{nm}$$

Question73

Consider the following statements :
(A) The principal quantum number ' n ' is a positive integer with values of ' n ' = 1, 2, 3, ...
(B) The azimuthal quantum number 'I' for a given 'n' (principal quantum number) can have values as 'I' = 0, 1, 2,..... n
(C) Magnetic orbital quantum number 'm' for a particular 'l' (azimuthal quantum number) has (2l + 1) values.
(D) ±1/2 are the two possible orientations of electron spin.
(E) For I = 5, there will be a total of 9 orbital
Which of the above statements are correct?
[28-Jun-2022-Shift-2]

Options:

A. (A), (B) and (C)

B. (A), (C), (D) and (E)

C. (A), (C) and (D)

D. (A), (B), (C) and (D)

Answer: C

Solution:

Solution:
(A) Principle quantum number n is a positive integer and it's possible values are $n = 1, 2, 3.....$
$\therefore A$ is correct.
(B) Azimuthal quantum number 'l' for a given ' n ' can have values as $I = 0, 1, 2..... (n-1)$
$\therefore$ Statement B is wrong.
(C) Magnetic orbital quantum number m_l for particular I has values from $-I$ to $+1$ including zero means $2l+1$ values.
$\therefore$ Statement C is correct.
(D) $\pm \frac{1}{2}$ are the two possible orientation of electron spin.
$\therefore$ Statement D is correct.
(E) For $I = 5$, there will be a total of 11 orbitals.
$l = 0 \Rightarrow 5$ subshell
$l = 1 \Rightarrow p$ subshell
$l = 2 \Rightarrow d$ subshell
$l = 3 \Rightarrow f$ subshell
$l = 4 \Rightarrow g$ subshell
$l = 5 \Rightarrow h$ subshell
We know,
Number of orbital in any subshell $= 2l + 1.$
$\therefore$ For h subshell, number of orbitals $= 2 \times 5 + 1 = 11$

Question74

Which of the following statements are correct?

(A) The electronic configuration of Cr is [Ar]$3d^5 4s^1$.
(B) The magnetic quantum number may have a negative value.
(C) In the ground state of an atom, the orbitals are filled in order of their increasing energies.
(D) The total number of nodes are given by n − 2.
Choose the most appropriate answer from the options given below : [29-Jun-2022-Shift-1]

Options:

A. (A), (C) and (D) only

B. (A) and (B) only

C. (A) and (C) only

D. (A), (B) and (C) only

Answer: D

Solution:

Solution:
(A) $Cr(24) = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$
$= [Ar]3d^5 4s^1$
(B) Magnetic quantum number (m) values ranging from $-I$ to $+|$ including zero.
∴ It can have negative value.
(C) According to Aufbau rule, electrons are filled first in these orbitals which have low energy.
∴ Statement C is correct.
(D) We know,
Number of Radial nodes $= n - I - 1$
and number of Angular nodes $= 1$
∴ Total nodes $= n - I - 1 + 1 = n - 1$

Question75

The electronic configuration of Pt (atomic number 78) is: [29-Jun-2022-Shift-1]

Options:

A. $[Xe]4f^{14}5d^{9}6s^{1}$

B. $[Kr]4f^{14}5d^{10}$

C. $[Xe]4f^{14}5d^{10}$

D. $[Xe]4f^{14}5d^{8}6s^{2}$

Answer: A

Solution:

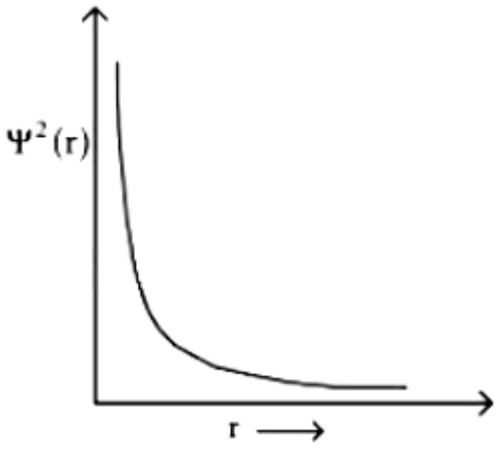
Solution:
Atomic number of Pt is 78
Electronic configuration is $_{78}Pt \rightarrow [Xe]4f^{14}5d^{9}6s^{1}$ (Exceptional electronic configuration)

Question76

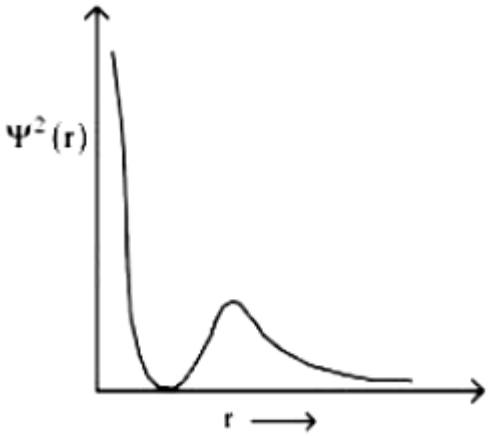
Which of the following is the correct plot for the probability density ψ^2 (r) as a function of distance ' r ' of the electron from the nucleus for 2s orbital?
[29-Jun-2022-Shift-2]

Options:

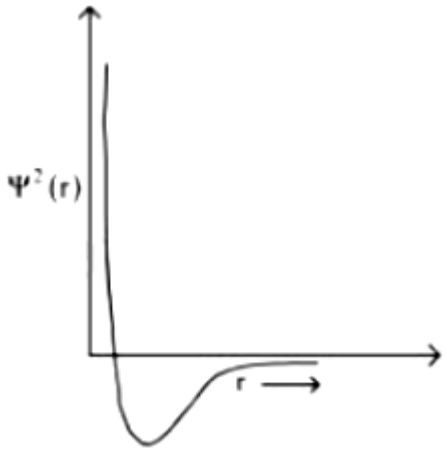
A.



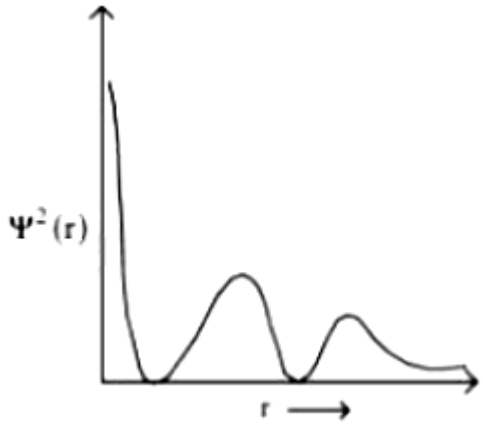
B.



C.



D.



Answer: B

Solution:

Solution:
Formula for number of radial nodes in n^{th} orbital $= n - l - 1$
For $2s$, number of radial nodes $= 2 - 0 - 1 = 1$ and value of ψ^2 is always positive.

Question77

Which of the following sets of quantum numbers is not allowed? [25-Jul-2022-Shift-1]

Options:

A. $n = 3, 1 = 2, m_1 = 0, s = +\frac{1}{2}$

B. $n = 3, l = 2, m_1 = -2, s = +\frac{1}{2}$

C. $n = 3, l = 3, m_1 = -3, s = -\frac{1}{2}$

D. $n = 3, l = 0, m_1 = 0, s = -\frac{1}{2}$

Answer: C

Solution:

Solution:
If $n = 3$, then possible values of $l = 0, 1, 2$
But in option (C), the value of 1 is given ' 3 ', this is not possible.

Question78

When the excited electron of a H atom from n = 5 drops to the ground state, the maximum number of emission lines observed are_____ [25-Jul-2022-Shift-2]

Answer: 10

Solution:

Solution:

Maximum number of emission lines

$= \frac{(n_2 - n_1)(n_2 - n_1 + 1)}{2}$

$n_2 = 5$

$n_1 = 1$

$\Rightarrow \frac{(5-1)(5-1+1)}{2} = 10$

Hence maximum number of emission lines observed are 10 .

Question79

The wavelength of an electron and a neutron will become equal when the velocity of the electron is x times the velocity of neutron. The value of x is _____.(Nearest Integer)

(Mass of electron is 9.1×10^{-31} kg and mass of neutron is 1.6×10^{-27} kg)

[26-Jul-2022-Shift-1]

Answer: 1758

Solution:

Solution:

$\lambda_e = \frac{h}{m_e \times V_e}, \quad \lambda_N = \frac{h}{m_N \times V_N}$

$\lambda_e = \lambda_N$ When $V_e = xV_N$

$\frac{1}{m_e V_e} = \frac{1}{m_N \times V_N}$

$\frac{m_N}{m_e} = \frac{V_e}{V_N} = x$

$x = \frac{1.6 \times 10^{-27}}{9.1 \times 10^{-31}}$

$= 0.17582 \times 10^4$

$\simeq 1758$

Question80

Consider an imaginary ion $_{22}{}^{48}X^{3-}$. The nucleus contains ' a ' % more neutrons than the number of electrons in the ion. The value of ' a ' is _____ . [nearest integer]
[26-Jul-2022-Shift-2]

Answer: 4

Solution:

Solution:
Number of electrons in $_{22}{}^{48}X^{3-}$ is 25 .
Number of neutrons $= 48 - 22 = 26.$
% increase in the number of neutrons over electrons
$= \left(\frac{26-25}{25} \right) 100 = 4\%$
$\therefore a = 4$

Question81

Given below are two statements. One is labelled as Assertion A and the other is labelled as Reason R.
Assertion A: Energy of 2s orbital of hydrogen atom is greater than that of 2s orbital of lithium.
Reason R: Energies of the orbitals in the same subshell decrease with increase in the atomic number.
In the light of the above statements, choose the correct answer from the options given below.
[27-Jul-2022-Shift-1]

Options:

A. Both A and R are true and R is the correct explanation of A.

B. Both A and R are true but R is N OT the correct explanation of A.

C. A is true but R is false.

D. A is false but R is true.

Answer: A

Solution:

Solution:
As the atomic number increases then the potential energy of electrons present in same shell becomes more and more negative. And therefore total energy also becomes more negative.

$E_{total} = -13.6 \frac{Z^2}{n^2} eV$

∴ Energies of the orbitals in the same subshell decreases with increase in atomic number.

Question82

The correct decreasing order of energy for the orbitals having, following set of quantum numbers :
(A) n = 3, I = 0, m = 0
(B) n = 4, I = 0, m = 0
(C) n = 3, I = 1, m = 0
(D) n = 3, l = 2, m = 1
is :
[27-Jul-2022-Shift-2]

Options:

A. (D) >(B) > (C) > (A)

B. (B) >(D) > (C) > (A)

C. (C) > (B) > (D) > (A)

D. (B) > (C) > (D) > (A)

Answer: A

Solution:

Solution:
(A) $n + \ell = 3 + 0 = 3$
(B) $n + \ell = 4 + 0 = 4$
(C) $n + \ell = 3 + 1 = 4$
(D) $n + \ell = 3 + 2 = 5$
Higher $n + \ell$ value, higher the energy \& if same $n + \ell$ value, then higher n value, higher the energy.
Thus : $D > B > C > A$.

Question83

Identify the incorrect statement from the following.
[28-Jul-2022-Shift-1]

Options:

A. A circular path around the nucleus in which an electron moves is proposed as Bohr's orbit.

B. An orbital is the one electron wave function (ψ) in an atom.

C. The existence of Bohr's orbits is supported by hydrogen spectrum.

D. Atomic orbital is characterised by the quantum numbers n and l only.

Answer: D

Solution:

Solution:
Atomic orbital is characterised by the quantum numbers n, l and m.
Hence option D is incorrect.

Question84

If the wavelength for an electron emitted from H-atom is 3.3×10^{-10}m, then energy absorbed by the electron in its ground state compared to minimum energy required for its escape from the atom, is times. (Nearest integer)
[Given : $h = 6.626 \times 10^{-34}$J s]
Mass of electron $= 9.1 \times 10^{-31}$ kg
[28-Jul-2022-Shift-2]

Answer: 2

Solution:

Solution:

$\lambda = \frac{h}{mv}$

$\Rightarrow mv = \frac{h}{\lambda} = \frac{6.626 \times 10^{-34}\,kg\,\frac{m^2}{sec^2} \times sec}{3.3 \times 10^{-10} m}$

$mv = \frac{6.626 \times 10^{-24}}{3.3} = 2 \times 10^{-24}\,kg\,m\ sec^{-1}$

Kinetic energy $= \frac{1}{2}mv^2$

$= \frac{(mv)^2}{2m}$

$= \frac{(2 \times 10^{-24})^2}{2 \times 9.1 \times 10^{-31}\,kg}$

$= 2.18 \times 10^{-18} J$

$= 21.8 \times 10^{-19} J$

Total energy absorbed = Ionization energy + Kinetic energy

$= (21.76 + 21.8) \times 10^{-19}$

$= 43.56 \times 10^{-19} J$

$\approx$2 times of $21.76 \times 10^{-19} J$

Question85

The minimum uncertainty in the speed of an electron in an one dimensional region of length $2a_o$ (Where a_o = Bohr radius 52.9 pm) is _____ $km\,s^{-1}$

(Given : Mass of electron $= 9.1 \times 10^{-31}$ kg, Planck's constant $h = 6.63 \times 10^{-34}$ Js)

[29-Jul-2022-Shift-1]

Answer: 548

Solution:

Solution:

Heisenberg's uncertainty principle

$\Delta x \times \Delta P_x \geq \frac{h}{4\pi}$

$\Rightarrow 2a_0 \times m \Delta v_x = \frac{h}{4\pi}(\text{ minimum })$

$\Rightarrow \Delta v_x = \frac{h}{4\pi} \times \frac{1}{2a_0} \times \frac{1}{m}$

$= 6.63 \times 10^{-34}$

$4 \times 3.14 \times 2 \times 52.9 \times 10^{-12} \times 9.1 \times 10^{-31}$

$= 548273 ms^{-1}$

$= 548.273 kms^{-1}$

$= 548 kms^{-1}$

Question86

Given below are the quantum numbers for 4 electrons.

A. $n = 3, 1 = 2, m_1 = 1, m_s = +1/2$

B. $n = 4, 1 = 1, m_1 = 0, m_s = +1/2$

C. $n = 4, 1 = 2, m_1 = -2, m_s = -1/2$

D. $n = 3, 1 = 1, m_1 = -1, m_s = +1/2$

The correct order of increasing energy is
[29-Jul-2022-Shift-2]

Options:

A. $D < B < A < C$

B. $D < A < B < C$

C. $B < D < A < C$

D. $B < D < C < A$

Answer: B

Solution:

Solution:
Energy of the sub-shell is given by, $(n+1)$ rule.
$A \Rightarrow 3d \Rightarrow n + 1 = 5$
$B \Rightarrow 4p \Rightarrow n + \lambda = 5$
$C \Rightarrow 4d \Rightarrow n + \ell \Rightarrow 6$

D ⇒ 3 s ⇒ (n + ℓ) = 4
D < A < B < C

Question87

Electromagnetic radiation of wavelength 663nm is just sufficient to ionise the atom of metal A. The ionisation energy of metal A in $kJ\ mol^{-1}$ is ..... .(Rounded off to the nearest integer)

[$h = 6.63 \times 10^{-34} J - s$, $c = 3.00 \times 10^{8} ms^{-1}$, $N_A = 6.02 \times 10^{23} mol^{-1}$]

[25 Feb 2021 Shift 2]

Answer: 180

Solution:

Solution:
Energy of EMR = IE of the metal (A)

$$= h\nu = \frac{hc}{\lambda} atom^{-1} = -\frac{hc}{\lambda} \times N_A mol^{-1}$$

$$= \frac{(6.63 \times 10^{-34}) \times (3 \times 10^{8}) \times (6.02 \times 10^{23})}{(663 \times 10^{-9})} J\ mol^{-1}$$

$[\because \lambda = 663nm = 663 \times 10^{-9} m]$

$$= 180600 J\ mol^{-1} = 180.6 kJ\ mol^{-1} \sim eq 180 kJ\ mol^{-1}$$

Question88

According to Bohr's atomic theory,

I. kinetic energy of electron is $\propto \frac{Z^2}{n^2}$

II. the product of velocity (v) of electron and principal quantum number (n), $'vn' \propto Z^2$.

III. frequency of revolution of electron in an orbit is $\propto \frac{Z^3}{n^3}$

IV. coulombic force of attraction on the electron is $\propto \frac{Z^3}{n^4}$

Choose the most appropriate answer from the options given below. [24 Feb 2021 Shift 2]

Options:

A. Only III

B. Only I

C. I, III and IV

D. I and IV

Answer: D

Solution:

Solution:
According to Bohr's theory,
I. $KE \propto \frac{Z^2}{n^2}$ or $13.6 \propto \frac{Z^2}{n^2}\frac{(eV)}{(\text{atom})}$ ($\therefore$ Correct)
II. Speed of electron $\propto \frac{Z}{n}$
(Here, Z = atomic number, $n =$ number of shells)
$\therefore \quad v \times n \propto Z$ ($\therefore$ Incorrect)
III. Frequency of revolution of electron $= \frac{v}{2\pi r}$
Frequency $\propto \frac{Z^2}{n^3}$ $\left(\because v \propto \frac{z}{n}, r \propto \frac{n^2}{z}\right)$ ($\therefore$ Incorrect)
IV. $F = \frac{kq_1q_2}{r^2} = \frac{kZe^2}{r^2}$
$F = \frac{Z}{\left(\frac{n^2}{Z}\right)^2}$
$F \propto \frac{Z^3}{n^4}$ ($\therefore$ Correct)
Hence, only I, and IV are correct.

Question89

A ball weighing 10g is moving with a velocity of $90ms^{-1}$. If the uncertainty in its velocity is 5%, then the uncertainty in its position is ..... $\times 10^{-33}$m (Rounded off to the nearest integer). [Given,

$h = 6.63 \times 10^{-34} J - s$]
[26 Feb 2021 Shift 2]

Answer: 1

Solution:

Solution:
According to Heisenberg's uncertainty equation,

$\Delta x \times m \Delta v \geq \frac{h}{4\pi}$ $(\therefore m = 10g = 10 \times 10^{-3} kg,\ v = 90 ms^{-1})$

Uncertainty in position,

$$\Delta x = \frac{h}{4\pi} \times \frac{1}{m \times \Delta v(\text{ with uncertainty })}$$

$$= \frac{6.63 \times 10^{-34}}{4 \times 3.14} \times \frac{1}{(10 \times 10^{-3}) \times \left(90 \times \frac{5}{100}\right)} m$$

$$= 1.17 \times 10^{-33} m$$

$$= 1 \times 10^{-33} m$$

Question90

Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) In TlI_3, isomorphous to CsI_3, the metal is present in +1 oxidation state.

Reason (R) Tl metal has fourteen f-electrons in the electronic configuration.

In the light of the above statements, choose the most appropriate answer from the options given below.

[26 Feb 2021 Shift 2]

Options:

A. A is correct but R is not correct.

B. Both A and R are correct and R is the correct explanation of A.

C. A is not correct but R is correct

D. Both A and R are correct but R is not correct explanation of A.

Answer: B

Solution:

Solution:
Assertion (A) is correct. TII_3 and CsI_3 are the triiodide, I_3^- (polyhalide) compounds of $TI^+$and Cs^+ions. Due to inert pair effect of group -13 elements, $Tl^+$is more stable than TH^{3+}. Cs and Tl belong to the same period (6th).
Sizes of $Cs^+$and $Tl^+$are nearly same.
So, geometrical network and lattice pattern of both CsI_3 and TII_3 are same (bcc lattice). Csl_3 and TII_3 are also able to form mixed crystals when crystallisation is carried out from a mixture of saturated solutions of CsI_3 and TII_3. These properties enable TII_3 and Csl_3 to be isomorphous crystals.
Reason (R) is also correct. Electronic configuration of $Cs\ (Z = 55)$ and $TI\ (Z = 81)$ as follows
$_{55}Cs : [_{54}Xe]6s^1$
$_{81}Tl : [_{54}Xe]4f^{14}{}_{5d}{}^{10}6s^26p^1$
So, Tl has fourteen f-electrons in the anti-penultimate (4th) shell. A and R are individually correct and R is the correct explanation of A.

Question91

The orbital having two radial as well as two angular nodes is [26 Feb 2021 Shift 1]

Options:

A. 3p

B. 4f

C. 4d

D. 5d

Answer: D

Solution:

Solution:
Number of radial nodes $= (n - I - 1)$
[$n =$ principal quantum number, $I =$ az imuthal quantum number] Number of angular nodes $= 1$
(a) $3p(n = 3, I = 1) \Rightarrow 1\ \ 1$

(b) $4f\,(n=4, I=3) \Rightarrow 0\ \ 3$
(c) $4d\,(n=4, I=2) \Rightarrow 1\ \ 2$
(d) $5d\,(n=5, I=2) \Rightarrow 2\ \ 2$
So, $5d$-orbital has two radial as well as two angular nodes (option-d). Note $I=0$ for s-orbital, $I=1$ for p-orbital, $I=2$ for d-orbital and $I=3$ for f−orbital.

Question92

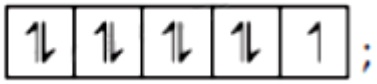
The spin only magnetic moment of a divaler ion in aqueous solution (atomic number = 29) is ..... BM.
[25 Feb 2021 Shift 2]

Answer: 2

Solution:

Solution:

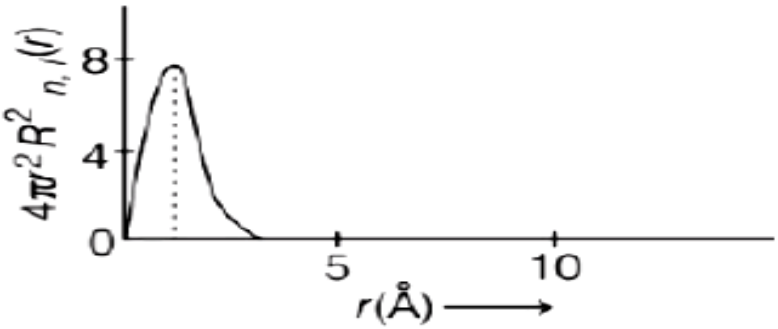
$Z=29[Cu] \xrightarrow{-2e^-} Cu^{2+}=[Ar]3d^9$

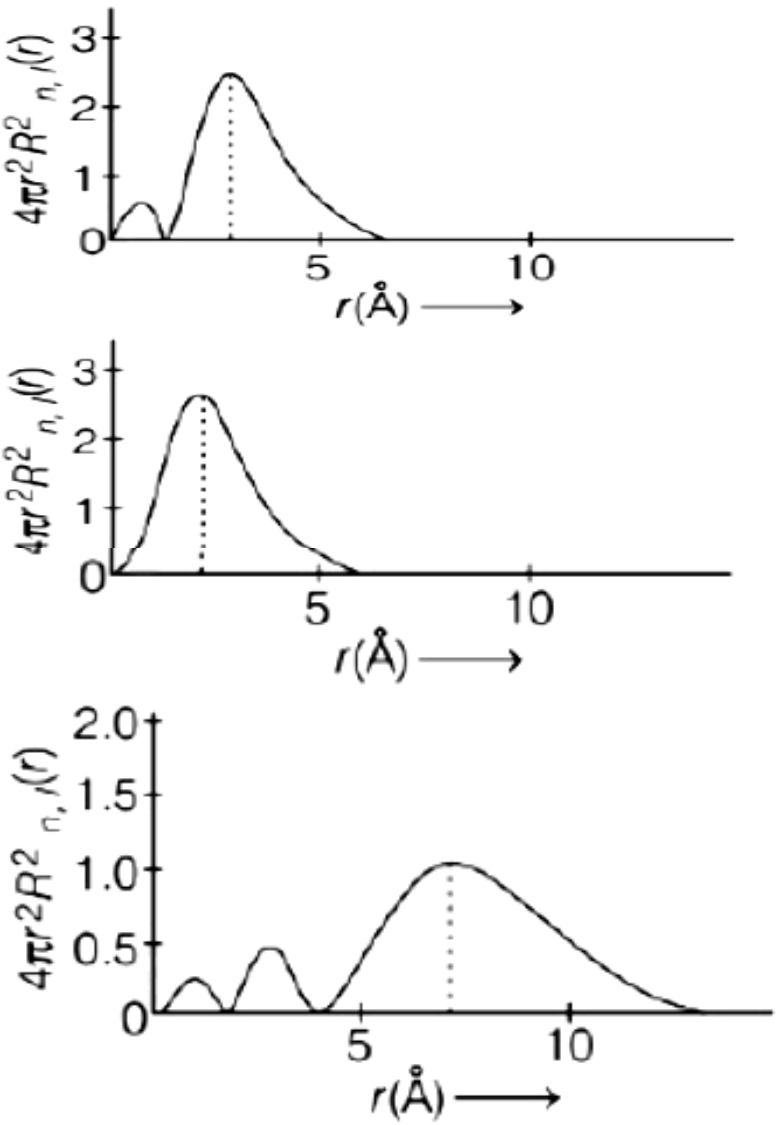
$3d^9=$  ;

Number of unpaired electron, $n=1$
∴ Spin only magnetic moment,
$\mu = \sqrt{n(n+2)}BM = \sqrt{1(1+2)}BM = \sqrt{3}BM$
$= 1.73BM = 2BM$

Question93

The plots of radial distribution functions for various orbitals of hydrogen atom against ' r ' are given below.





The correct plot for 3s-orbital is
[25 Feb 2021 Shift 1]

Options:

A. (A)

B. (B)

C. (C)

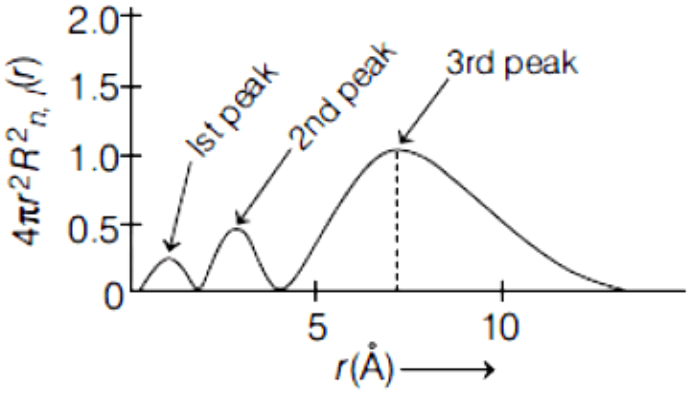
D. (D)

Answer: D

Solution:

Solution:

The correct plot for 3s-orbital is



For 3s,
value of $I = 0$
value of $n = 3$
Number of peak $= n - I = 3 - 0 = 3$
In graph D, three peaks are present, so this is the correct plot for 3s-orbital.

Question94

A proton and a Li^{3+} nucleus are accelerated by the same potential. If λ_{Li} and λ_P denote the de Broglie wavelengths of Li^{3+} and proton respectively, then the value of $\frac{\lambda_{Li}}{\lambda_P}$ is $x \times 10^{-1}$. The value of x is _____(Rounded off to the nearest integer) (Mass of Li^{3+} = 8.3 mass of proton)
[24feb2021shift1]

Answer: 2

Solution:

Solution:

$$\lambda = \frac{h}{\sqrt{2mqV}}$$

$$\frac{\lambda_{Li}}{\lambda_P} = \sqrt{\frac{m_P(e)V}{m_{Li}(3e)(V)}} \quad m_{Li} = 8.3m_P$$

$$\frac{\lambda_{Li}}{\lambda_P} = \sqrt{\frac{1}{8.3 \times 3}} = \frac{1}{5} = 0.2 = 2 \times 10^{-1}$$

Question95

Given below are two statements.
Statement I Bohr's theory accounts for the stability and line spectrum of Li^{+}ion.
Statement II Bohr's theory was unable to explain the splitting of spectral lines in the presence of a magnetic field.
In the light of the above statements, choose the most appropriate answer from the options given below:
[18 Mar 2021 Shift 2]

Options:

A. Both statements I and II are true.

B. Statement I is false but statement II is true.

C. Both statements I and II are false.

D. Statement I is true but statement II is false.

Answer: B

Solution:

Solution:
Statement I is false, because Bohr's theory accounts for the stability and spectrum of single electronic species (e.g. He^{+}, Li^{2+} etc.) but Li^{+}has two electrons.
Bohr's theory fails to explain splitting of spectral lines in presence of magnetic field i.e. Zeeman effect.
∴ Statement II is true.

Question96

When light of wavelength 248nm falls on a metal of threshold energy 3.0eV , the de-Broglie wavelength of emitted electrons is ..... Å.
[Round off to the nearest integer]
[Use: $\sqrt{3} = 1.73$, $h = 6.63 \times 10^{-34}$J s
$m_e = 9.1 \times 10^{-31}$kg, $c = 3.0 \times 10^{8}ms^{-1}$

$1eV = 1.6 \times 10^{-19} J$]
[16 Mar 2021 Shift 1]

Answer: 9

Solution:

Solution:
Given wavelength, if incident light $(\lambda) = 248nm = 2480Å$
Threshold energy $= 3.0eV$
We know, for electron de-Broglie wavelength is given by

$$\lambda = \frac{h}{mv}$$

$$\lambda = \frac{h}{\sqrt{2m(KE)}}$$

$KE = q \times V$ (where, $q =$ charge of particle)
$V =$ voltage applied

$$\lambda = \frac{h}{\sqrt{2m(qV)}}$$

Putting mass of electron, $m_e = 9.1 \times 10^{-31} kg$
Charge of electron, $q = 1.6 \times 10^{-19} C$

$$\lambda = \sqrt{\frac{150}{V}} Å ....(i)$$

We know, $E_{applied} = \varphi + K_{max}$....(ii)
where, $\varphi =$ threshold energy
$\varphi = 3eV$

$$E_{applied} = \frac{12400}{\lambda_{Å}} = \frac{12400}{2480} = 5eV$$

Putting value in Eq. (ii),
$5 = 3 + K_{max}$
$\Rightarrow KE_{max} = 2eV$
$\text{Voltage} = 2$

$$\lambda_e = \sqrt{\frac{150}{2}} = 8.6Å \qquad \text{[Eq. (i)]}$$

Nearest integer $= 9$

Question97

A certain orbital has no angular nodes and two radial nodes. The orbital is
[18 Mar 2021 Shift 1]

Options:

A. 2s

B. 3s

C. 3p

D. 2p

Answer: B

Solution:

Solution:
As, we know,
For 2s orbital, $n = 2, I = 0$
Angular node $(l) = 0$
Radial nodes $= n - 1 - 1 \text{ Rightarrow } 2 - 0 - 1 = 1$
For 2p orbital, $n = 2$ and $I = 1$
Angular node $(l) = 1$
Therefore, number of radial nodes $= 2 - 1 - 1 = 0$
It has one angular and zero radial node.

For 3p orbital, $n = 3, I = 1$
Angular node $(l) = 1$
It has one angular and one radial node.
For 3s orbital, $n = 3, I = 0$
No. of angular node $(l) = 0$
No. of radial node $\text{Rightarrow } n - I - 1$
$= 3 - 0 - 1 = 2 = 2$
Hence, for 3 s-orbital has no angular node and 2 radial nodes.

Question98

A certain orbital has n = 4 and $m_l = -3$. The number of radial nodes in this orbital is (Round off to the nearest integer). [17 Mar 2021 Shift 1]

Answer: 0

Solution:

Solution:

Given, $n = 4, m_l = -3$, so $l = 3$
Possible value of $I = 0, 1, 2, 3$
As $m = -3$ is possible only for $I = 3$
For $l = 3, m_l = -3, -2, -1, 0, 1, 2, 3$
So, this is $4f$-orbital.
Number of radial nodes $= n - l - 1$
$= 4 - 3 - 1$
$= 0$
So, there is no radial node in $4f$ orbital.

Question99

The number of orbitals with n = 5, m_1 = +2 is (Round off to the nearest integer).
[16 Mar 2021 Shift 2]

Answer: 3

Solution:

Solution:
Given, $n = 5, m_l = +2$
For $n = 5$, possible value of $I = 0, 1, 2, 3, 4$
For $l = 0, m_l = 0$
$l = 1, m_l = -1, 0, 1$
$l = 2, m_l = -2, -1, 0, 1, 2$
$l = 3, m_l = -3, -2, -1, 0, 1, 2, 3$
$l = 4, m_l = -4, -3, -2, -1, 0, 1, 2, 3, 4$
Possible value of m_l for a given value of l
$= 0, \pm 1, \pm 2, \pm 3 \ldots \pm l$
So, number of orbitals having $n = 5$ and $m_l = \pm 2$ are 3 .

Question100

If the Thompson model of the atom was correct, then the result of Rutherford's gold foil experiment would have been:

[27 Jul 2021 Shift 2]

Options:

A. All of the α-particles pass through the gold foil without decrease in speed.

B. α-Particles are deflected over a wide range of angles.

C. All α-particles get bounced back by 180°

D. α-Particles pass through the gold foil deflected by small angles and with reduced speed.

Answer: D

Solution:

Solution:
As in Thomson model, protons are diffused (charge is not centred) α - particles deviate by small angles and due to repulsion from protons, their speed decreases.

Question101

Given below are two statements :
Statement I : Rutherford's gold foil experiment cannot explain the line spectrum of hydrogen atom.
Statement II : Bohr's model of hydrogen atom contradicts Heisenberg's uncertainty principle.
In the light of the above statements, choose the most appropriate answer from the options given below :
[27 Jul 2021 Shift 1]

Options:

A. Statement I is false but statement II is true.

B. Statement I is true but statement II is false.

C. Both statement I and statement II are false.

D. Both statement I and statement II are true.

Answer: D

Solution:

Solution:
Rutherford's gold foil experiment only proved that electrons are held towards nucleus by electrostatic forces of attraction and move in circular orbits with very high speeds.
Bohr's model gave exact formula for simultaneous calculation of speed & distance of electron from the nucleus, something which was deemed impossible according to Heisenberg.

Question102

An accelerated electron has a speed of $5 \times 10^{6} ms^{-1}$ with an uncertainty of 0.02%. The uncertainty in finding its location while in motion is $x \times 10^{-9} m$.
The value of x is _____ . (Nearest integer)
[Use mass of electron $= 9.1 \times 10^{-31} kg, h = 6.63 \times 10^{-34} J\ s, \pi = 3.14$]
[25 Jul 2021 Shift 2]

Answer: 58

Solution:

Solution:

$$\Delta v = \frac{0.02}{100} \times 5 \times 10^{6} = 10^{3} m/s$$

$$\Delta x \,.\, \Delta v = \frac{h}{4\pi m}$$

$$x \times 10^{-9} \times 10^{3} = \frac{6.63 \times 10^{-34}}{4 \times 3.14 \times 9.1 \times 10^{-31}} x \times 10^{-9} \times 10^{3} = 0.058 \times 10^{-3}$$

$$x = \frac{0.058 \times 10^{-6}}{10^{-9}} = 58$$

Question103

A source of monochromatic radiation of wavelength 400nm provides 1000J of energy in 10 seconds. When this radiation falls on the surface of sodium, $x \times 10^{20}$ electrons are ejected per second. Assume

that wavelength 400nm is sufficient for ejection of electron from the surface of sodium metal. The value of x is _____.
(Nearest integer)
($h = 6.626 \times 10^{-34}$ J s)
[25 Jul 2021 Shift 1]

Answer: 2

Solution:

Solution:
Total energy provided by
Source per second $= \frac{1000}{10} = 100\text{J}$

Energy required to eject electron $= \frac{hc}{\lambda}$

$= \frac{6.626 \times 10^{-34}}{400 \times 10^{-9}} \times 3 \times 10^{8}$

Number of electrons ejected $= \frac{100}{\frac{6.626 \times 10^{-34} \times 3 \times 10^{8}}{400 \times 10^{-9}}}$

$= \frac{400 \times 10^{-7} \times 10^{26}}{6.626 \times 3}$

$= \frac{40 \times 10^{-20}}{6.626 \times 3}$

$= 2.01 \times 10^{20}$

Question104

The wavelength of electrons accelerated from rest through a potential difference of 40kV is $x \times 10^{-12}$m. The value of x is _____ . (Nearest integer)
Given : Mass of electron $= 9.1 \times 10^{-31}$kg
Charge on an electron $= 1.6 \times 10^{-19}$C
Planck's constant $= 6.63 \times 10^{-34}$J S
[20 Jul 2021 Shift 2]

Answer: 6

Solution:

Solution:

De-broglie-wave length of electron:

$\lambda_e = \frac{h}{\sqrt{2m(KE)}}$ {$\because e^-$ is accelerated from rest $\Rightarrow KE = q \times V$

$\lambda = \frac{h}{\sqrt{2mqv}}$

$= \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 1.6 \times 10^{-19} \times 9.1 \times 10^{-31} \times 40 \times 10^3}}$

$= 0.614 \times 10^{-11} m$

$= 6.14 \times 10^{-12} m$

Nearest integer $= 6$

Question105

The kinetic energy of an electron in the second Bohr orbit of a hydrogen atom is equal to $\frac{h^2}{xma_0^2}$. The value of 10x is ..... (a_0 is radius of Bohr's orbit) (Nearest integer)
[Given, π = 3.14]
[27 Aug 2021 Shift 1]

Answer: 3155

Solution:

Solution:

$\because$ Angular moment is given as,

$mvr = \frac{nh}{2\pi}$

$\therefore$ Kinetic energy $= \frac{n^2h^2}{8\pi^2mr^2} = \frac{4h^2}{8\pi^2m(4a_0)^2}$

$= \left(\frac{4}{8\pi^2 \times 16}\right)\frac{h^2}{ma_0^2} = \frac{h^2}{xma_0^2}$

$x = \frac{4}{8\pi^2 \times 16}$
$\Rightarrow x = 315.507$
$10x = 3155.07$

Question106

Given below are two statements.
Statement I According to Bohr's model of an atom, qualitatively the magnitude of velocity of electron increases with decrease in positive charges on the nucleus as there is no strong hold on the electron by the nucleus.
Statement II According to Bohr's model of an atom, qualitatively the magnitude of velocity of electron increases with decrease in principal quantum number.In the light of the above statements, choose the most appropriate answer from the options given below. [26 Aug 2021 Shift 1]

Options:

A. Both statement I and statement II are false.

B. Both statement I and statement II are true.

C. Statement I is false but statement II is true.

D. Statement I is true but statement II is false.

Answer: C

Solution:

Solution:
According to Bohr's atom, velocity of electron is given by,
$v \propto \frac{Z}{n}$ ...(i)
where, v = velocity of electron
where, v = velocity of electron
n = principal quantum number
From Eq. (i), velocity of electron is directly proportional to atomicnumber of atom, corresponding to positive charge. So, as Z increases velocity also increases.
Hence, statement I is false. Also, velocity of electron is inversely proportional to n i.e. as ‘n’ decreases velocity of electron increases.
So, statement II is true.

Question107

The number of photons emitted by a monochromatic (single frequency) infrared range finder of power 1 mW and wavelength of 1000 nm, in 0.1 second is $x \times 10^{13}$. The value of x is ..... (Nearest integer) ($h = 6.63 \times 10^{-34}$ Js, $c = 3.00 \times 10^{8} ms^{-1}$)
[27 Aug 2021 Shift 2]

Answer: 50

Solution:

Solution:

Power of the source $= 1\,mW = 10^{-3}W$

Energy of one photon, $E = hv = \frac{hc}{\lambda}$

where, $h = 6.6 \times 10^{-34}$ Js

$c = 3 \times 10^{8} m/s$ and

λ = 1000 nm

$= 1000 \times 10^{-9} m$ $(1\,nm = 10^{-9} m)$

$= 10^{-6} m$

$E = \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{10^{-6}} \cong 20 \times 10^{-20} J$

Power = number of photons emitted in one second × energy of 1 photon.

$10^{-3} = n \times 20 \times 10^{-20}$

$\Rightarrow n = \frac{10^{-3}}{20 \times 10^{-20}} = 0.5 \times 10^{16}$

Number of photons emitted in $1s = 0.5 \times 10^{16}$

Number of photons emitted in $0.1s = 0.5 \times 10^{16} \times 0.1 = 50 \times 10^{13}$

$x \times 10^{13} = 50 \times 10^{13}$

x = 50

Question108

A metal surface is exposed to 500 nm radiation. The threshold frequency of the metal for photoelectric current is 4.3×10^{14} Hz. The velocity of ejected electron is ..... $\times 10^{5} ms^{-1}$. (Nearest integer)

[Use $h = 6.63 \times 10^{-34}$ Js, $m_e = 9.0 \times 10^{-31}$ kg]
[26 Aug 2021 Shift 2]

Answer: 5

Solution:

Solution:

According to photoelectric effect $= \frac{hc}{\lambda} = hv_0 + \frac{1}{2}mv^2$
(where, h = Planck's constant, λ = wavelength
$v_0 =$ threshold frequency, v = velocity of electron
m = mass of electron, c = speed of light)

$\Rightarrow \frac{6.63 \times 10^{-34} \times 310^8}{500 \times 10^{-9}}$

$= 6.63 \times 10^{-34} \times 4.3 \times 10^{14} + \frac{1}{2}mv^2$

$\frac{6.63 \times 30 \times 10^{-19}}{50} = 6.63 \times 4.3 \times 10^{-20} + \frac{1}{2}mv^2$

$11.271 \times 10^{-20}\text{J} = \frac{1}{2} \times 9 \times 10^{-31} \times v^2$

$v = 5 \times 10^5 \text{m/s}$
∴ x = 5

Question109

The value of magnetic quantum number of the outermost electron of Zn^+ ion is
[31 Aug 2021 Shift 2]

Answer: 0

Solution:

Solution:

The configuration of $Zn^{+} = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$
The outermost electron is in s-orbital.
For s-orbital, azimuthal quantum number (l) = 0
Magnetic quantum number, m = − l to + l
For l = 0, m = 0

Question110

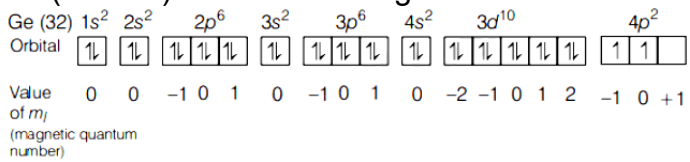
Ge(Z = 32) in its ground state electronic configuration has x completely filled orbitals with $m_l = 0$. The value of x is

[31 Aug 2021 Shift 1]

Answer: 7

Solution:

Solution:
Ge (Z = 32) electronic configuration is



For s-orbitals (1s, 2s, 3s and 4s) $m_l = 0\{2 \times 0\}$

For p-orbitals (2p, 3p)$m_l = 0\{(-1) \times 2 + 0 \times 2 + (+1) \times 2 = 0\}$

For d-orbitals $(3d)m_l = 0 \left\{ \begin{array}{c} (-2) \times 2 + (-1) \times 2 + 0 \times 2 \\ (+1) \times 2 + (+2) \times 2 = 0 \end{array} \right\}$

∴ Completely filled orbitals with m_l = 0 are seven (7).

Question111

A 50 watt bulb emits monochromatic red light of wavelength of 795 nm. The number of photons emitted per second by the bulb is $x \times 10^{20}$. The value of x is .....

[Given, $h = 6.63 \times 10^{-34}$ Js and $c = 3.0 \times 10^8 ms^{-1}$]

[1 Sep 2021 Shift 2]

Answer: 2

Solution:

Solution:
Energy of photon is given as

$E = \frac{nhc}{\lambda}$ ...(i)

where, E = energy of photon (50 W),
n = number of photon
h = Planck's constant $(6.63 \times 10^{-34}\,Js)$
c = speed of light $(3 \times 10^{8} m/s)$
λ = wavelength of light $(795 \times 10^{-9} m)$
E = 50 W = 50 J = energy of photon

$$50J = \frac{n \times 6.63 \times 10^{-34} Js \times 3 \times 10^{8} m/s}{795 \times 10^{-9} m}$$

$$\Rightarrow n = \frac{50 \times 795 \times 10^{-9}}{6.63 \times 10^{-34} \times 3 \times 10^{8}} = 1998.49 \times 10^{17} = 1.998 \times 10^{20} = 2 \times 10^{20}$$

$\therefore x = 2$
$\therefore$ Answer is 2.

Question112

For the Balmer series in the spectrum of H atom,

$\bar{v} = R_H \left\{ \frac{1}{n_1^2} - \frac{1}{n_2^2} \right\}$, the correct statements among (I) to (IV) are:

(I) As wavelength decreases, the lines in the scries converge
(II) The integer n_1 is equal to 2
(III) The lines of longest wavelength corresponds to $n_2 = 3$
(IV) The ionization energy of hydrogen can be calculated from wave number of these lines
[Jan. 08,2020 (I)]

Options:

A. (I), (III), (IV)

B. (I), (II), (III)

C. (I), (II), (IV)

D. (II), (III), (IV)

Answer: B

Solution:

Solution:
In the Balmer series of H-atom the transition takes place from the higher oribtal to $n = 2$. Therefore the longest wave length corresponds to $n_1 = 2$ and $n_2 = 3$. As the wave length decreases, the lines in the series converges. Hence, statement I, II, III are the correct statements among the given options.

Question113

The radius of the second Bohr orbit, in terms of the Bohr radius, a_0, in Li^{2+} is:
[Jan. 08, 2020 (II)]

Options:

A. $\frac{2a_0}{3}$

B. $\frac{4a_0}{9}$

C. $\frac{4a_0}{3}$

D. $\frac{2a_0}{9}$

Answer: C

Solution:

Solution:

$r = \frac{a_0 n^2}{Z}$

For Li^{2+}, $r = \frac{a_0(2)^2}{3} = \frac{4a_0}{3}$

Question114

The de Broglie wavelength of an electron in the 4 th Bohr orbit is: [Jan. 09, 2020 (I)]

Options:

A. $2\pi a_0$

B. $4\pi a_0$

C. $6\pi a_0$

D. $8\pi a_0$

Answer: D

Solution:

Solution:

$2\pi r = n\lambda$

$r = \frac{n^2 a_0}{Z}$

$2\pi \times \frac{4^2}{1} a_0 = 4\lambda$

$\lambda = 2\pi \times \frac{4}{1} a_0$

$\lambda = 8\pi a_0$

Question115

The number of orbitals associated with quantum numbers $n = 5, m_s = + \frac{1}{2}$ is: [NV, Jan. 07,2020(I)]

Options:

A. 11

B. 25

C. 50

D. 15

Answer: B

Solution:

Solution:
The possible number of orbitals in a shell in term of "n ' is n^2
$\therefore n = 5; n^2 = 25$

Question116

The difference between the radii of 3 rd and 4 th orbits of Li^{2+} is ΔR_1. The difference between the radii of 3 rd and 4 th orbits of He^{+} is ΔR_2. Ratio $\Delta R_1 : \Delta R_2$ is :
[Sep .05,2020 (I)]

Options:

A. 8 : 3

B. 3 : 8

C. 2 : 3

D. 3 : 2

Answer: C

Solution:

Solution:
$r = 0.529 \frac{n^2}{Z} Å$
For Li^{2+},
$\left(r_{Li^{2+}}\right)_{n=4} - \left(r_{Li^{2+}}\right)_{n-3} = \frac{0.529}{3}[4^2 - 3^2] = \Delta R_1$
For He^{+},
$\left(r_{He^{+}}\right)_{n=4} - \left(r_{He^{+}}\right)_{n=3} = \frac{0.529}{2}[4^2 - 3^2] = \Delta R_2$
$\frac{\Delta R_1}{\Delta R_2} = \frac{2}{3}$

Question117

The region in the electromagnetic spectrum where the Balmer series lines appear is:
[Sep. 04, 2020 (I)]

Options:

A. Visible

B. Microwave

C. Infrared

D. Ultraviolet

Answer: A

Solution:

Solution:
In hydrogen spectrum maximum lines of Balmer series lies in visible region.

Question118

The shortest wavelength of H atom in the Lyman series is λ_1. The longest wavelength in the Balmer series is He^+ is:
[Sep. 04, 2020 (II)]

Options:

A. $\frac{36\lambda_1}{5}$

B. $\frac{5\lambda_1}{9}$

C. $\frac{9\lambda_1}{5}$

D. $\frac{27\lambda_1}{5}$

Answer: C

Solution:

Solution:
Shortest wavelength → Max. energy $(\infty \rightarrow 1)$
For Lyman series of H atom,

$$\frac{1}{\lambda_1} = R_H (1)^2 \left[\frac{1}{1} - 0 \right]$$

$$\Rightarrow \frac{1}{\lambda_1} = R_H \Rightarrow R_H = \frac{1}{\lambda_1}$$

For Balmer series of He^+,

$$\frac{1}{\lambda} = R_H (2)^2 \left[\frac{1}{2^2} - \frac{1}{3^2} \right] \Rightarrow \frac{1}{\lambda} = R_H (4) \left(\frac{9-4}{36} \right)$$

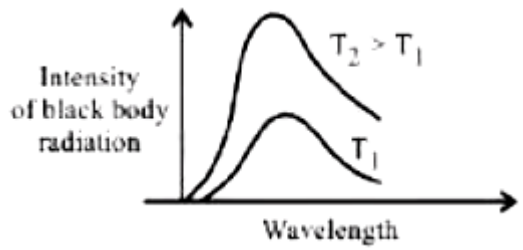
$$\Rightarrow \frac{1}{\lambda} = \frac{5R_H}{9} \Rightarrow \lambda = \frac{9}{5R_H} = \frac{9\lambda_1}{5}$$

Question119

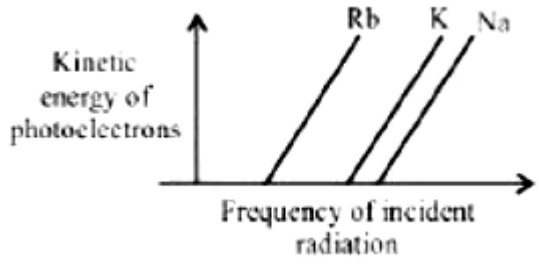
The figure that is not a direct manifestation of the quantum nature of atoms is :
[Sep. 02, 2020 (I)]

Options:

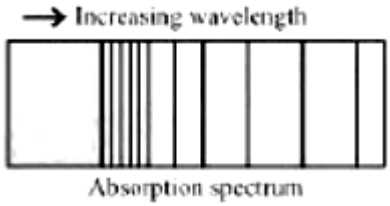
A.



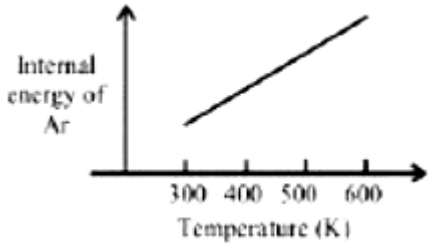
B.



C.



D.



Answer: D

Solution:

Solution:
(d) (a), (b) and (c) are according to quantum theory but (d) is statement of kinetic theory of gases.

Question120

The work function of sodium metal is 4.41×10^{-19}J . If photons of wavelength 300nm are incident on the metal, the kinetic energy of the ejected clectrons will be

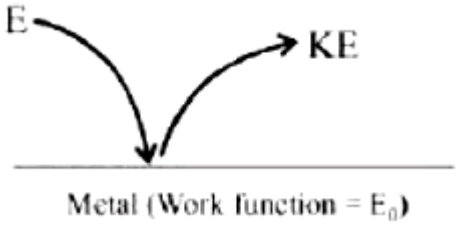
($h = 6.63 \times 10^{-34}$J s; $c = 3 \times 10^{8}$m/s) $\times 10^{-21}$J

[NV, Sep. 02, 2020(II)]

Answer: 222

Solution:

Solution:



$E = E_0 + (KE)_{max}$

$\frac{hc}{\lambda} = 4.41 \times 10^{-19} + KE$

$\frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{300 \times 10^{-9}} = 4.41 \times 10^{-19} + KE$

So, $(KE)_{max} = 6.63 \times 10^{-19} - 4.41 \times 10^{-19}$

$= 2.22 \times 10^{-19} J = 222 \times 10^{-21} J$

Question121

In the sixth period, the orbitals that are filled are: [Sep. 05,2020 (I)]

Options:

A. 6s, 4f , 5d , 6p

B. 6s, 5d , 5f , 6p

C. 6s, 5f , 6d , 6p

D. 6s, 6p, 6d , 6f

Answer: A

Solution:

Solution:

	6s	*4f*	*5d*	*6p*
$n+1$	$6+0$	$4+3$	$5+2$	$6+1$
	⇩	⇩	⇩	⇩
	6	7	7	7

Thus, order of orbitals filled are
$6s < 4f < 5d < 6p$

Question122

The correct statement about probability density (except at infinite distance from nucleus) is:
[Sep. 05, 2020 (II)]

Options:

A. It can be zero for 1s orbital

B. It can be negative for 2p orbital

C. It can be zero for 3p orbital

D. It can never be zero for 2s orbital

Answer: C

Solution:

Solution:
Radial node $= n - l - 1$
$\therefore 1s \Rightarrow 0(\psi^2 \neq 0)$
$2s \Rightarrow 1(\psi^2 = 0)$
$2p \Rightarrow 0(\psi^2 \neq 0)$
$3p \Rightarrow 1(\psi^2 = 0)$
Probability density (ψ^2) can be zero for $3p$ orbital other than infinite distance. It has one radial node.
Thus, statement (c) is correct.

Question123

Consider the hypothetical situation where the azimuthal quantum number, l , takes values 0, 1, 2, …. . n + 1, where n is the principal quantum number. Then, the element with atomic number:
[Sep. 03, 2020 (II)]

Options:

A. 9 is the first alkali metal

B. 13 has a half-filled valence subshell

C. 8 is the first noble gas

D. 6 has a 2p -valence subshell

Answer: B

Solution:

Solution:
Under the given situation for $n = 1, l = 0, 1, 2$
$n = 2, l = 0, 1, 2, 3$
$n = 3, l = 0, 1, 2, 3, 4$
According to $(n + l)$ rule of order of filling of subshells will be:
$1s1p1d\ 2s2p3s2d\ 3f$
Atomic number $1s^2 1p^4$
Atomic number $1s^2 1p^6 1d^1$
Atomic number $1s^2 1p^6$
Atomic number $1s^2 1p^6 1d^5$
Therefore option (b) is correct. Atomic number of first noble gas will be $18(1s^2 1p^6 1d^{10})$.

Question124

The number of subshells associated with n = 4 and m = −2 quantum numbers is:
[Sep. 02,2020 (II)]

Options:

A. 8

B. 2

C. 16

D. 4

Answer: B

Solution:

Solution:
For $n = 4$ possible values of $l = 0, 1, 2, 3$; only $l = 2$ and $l = 3$ can have $m = -2$. So possible subshells are 2.

Question125

What is the work function of the metal if the light of wavelength 4000Å generates photoelectrons of velocity $6 \times 10^5 ms^{-1}$ from it ? (Mass of electron $= 9 \times 10^{-31} kg$ Velocity of light $= 3 \times 10^8 ms^{-1}$ Planck's constant $= 6.626 \times 10^{-34} J\ s$ Charge of electron $= 1.6 \times 10^{-19} J\ eV^{-1}$) [Jan. 12, 2019 (I)]

Options:

A. 0.9eV

B. 3.1eV

C. 2.1eV

D. 4.0eV

Answer: C

Solution:

Solution:

$$E = hv = \frac{hc}{\lambda}$$

$$E = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{4000 \times 10^{-10}} = 4.97 \times 10^{-19} J$$

$$= \frac{4.97 \times 10^{-19} J}{1.6 \times 10^{-10} J\, eV^{-1}} = 3.1 eV$$

$$KE = \frac{1}{2} mv^2 = \frac{1}{2} \times 9 \times 10^{-31} kg \times (6 \times 10^5 ms^{-1})^2$$

$$= 1.62 \times 10^{-19} J\ [1J = kg \cdot m^2 s^{-2}]$$

$$= 1cV$$

According to photoelectric effect,

$$K.E. = hv - hv_0$$

$$hv_0 = hv - K.E$$

Work function $(W_0) = E - K.E$

$$= 3.1 - 1 = 2.1 eV$$

Question126

Heat treatment of muscular pain involves radiation of wavelength of about 900nm. Which spectral line of H atom is suitable for this purpose?
[$R_H = 1 \times 10^5 cm^{-1} \cdot h = 6.6 \times 10^{-34} J\ s, c = 3 \times 10^8 ms^{-1}$]
[Jan. 11, 2019 (I)]

Options:

A. Paschen, $\infty \rightarrow 3$

B. Paschen, $5 \rightarrow 3$

C. Balmer, $\infty \rightarrow 2$

D. Lyman, $\infty \rightarrow 1$

Answer: A

Solution:

Solution:

$$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$n_1 = 3, n_2 = \infty$

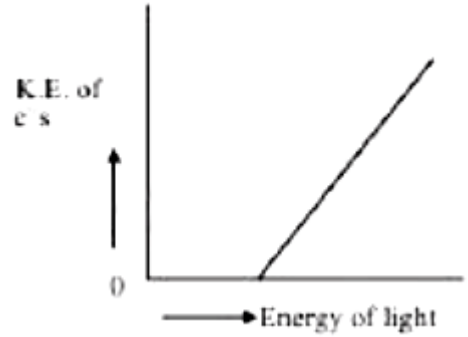
$$\frac{1}{\lambda} = R\left(\frac{1}{9}\right) \Rightarrow \lambda = \frac{9}{R} = \frac{9}{10^5} = 9 \times 10^{-5} cm = 900nm$$

Question127

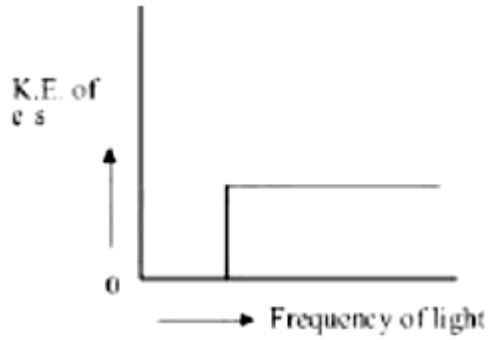
Which of the graphs shown below does not represent the relationship between incident light and the electron cjected from metal surface?
[Jan. 10, 2019 (I)]

Options:

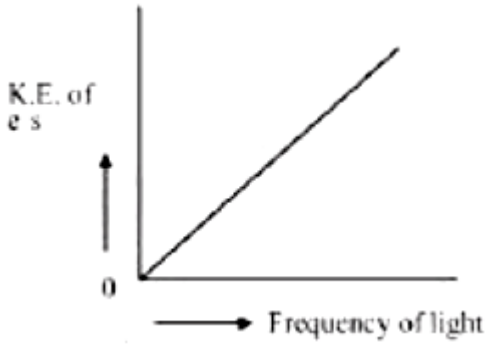
A.



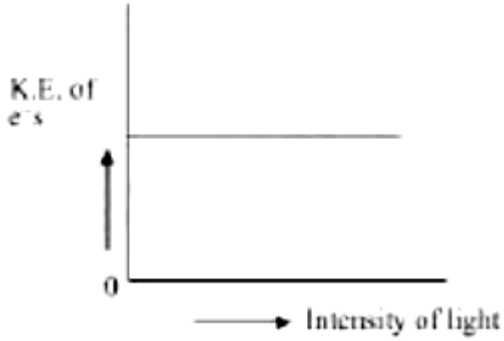
B.



C.



D.



Answer: C

Solution:

Solution:

$K.E. = h\nu - h\nu_0$

where, $\nu =$ Frequency of incident radiation

$\nu_0 =$ Threshold frequency

KE is independent of intensity but it depends on frequency of light. Intensity is directly proportional to the no. of electrons emitted.

Question128

The ground state energy of hydrogen atom is $-13.6eV$. The energy of second excited state of He^+ ion in eV is: [Jan. 10, 2019 (II)]

Options:

A. -54.4

B. -3.4

C. -6.04

D. -27.2

Answer: C

Solution:

Solution:

According to Bohr's model energy in n^{th} state

$$= -13.6 \times \frac{Z^2}{n^2} eV$$

For second excited state, of He^+, $n = 3$

$$\therefore E_3(He^+) = -13.6 \times \frac{2^2}{3^2} eV = -6.04eV$$

Question129

For emission line of atomic hydrogen from $n_i = 8$ to $n_f = n$ the plot of wave number $(\bar{\nu})$ against $\left(\frac{1}{n^2}\right)$ will be (The Rydberg constant, R_H is

in wave number unit)
[Jan. 9,2019 (I)]

Options:

A. Linear with intercept $-R_H$

B. Non linear

C. Linear with slope R_H

D. Linear with slope $-R_H$

Answer: D

Solution:

Solution:
As we know,

$$\bar{v} = -R_H \left(\frac{1}{n_2^2} - \frac{1}{n_1^2} \right) Z^2 \text{ (where, } Z = 1)$$

After putting the values, we get

$$\bar{v} = -R_H \left(\frac{1}{n^2} - \frac{1}{8^2} \right) \Rightarrow \bar{v} = \frac{R_H}{64} - \frac{R_H}{n^2}$$

Comparing to $y = mx + c$, we get

$$x = \frac{1}{n^2} \text{ and } m = -R_H \text{ (slope)}$$

Question130

If the de Broglie wavelength of the electron in n th Bohr orbit in a hydrogenic atom is equal to $1.5\pi a_0$(a_0 is Bohr radius), then the value of n/z is:
[Jan. 12, 2019 (II)]

Options:

A. 0.40

B. 1.50

C. 1.0

D. 0.75

Answer: D

Solution:

Solution:
Given $\lambda = 1.5\pi a_0$

$n\lambda = 2\pi r$ . . . (i)

Radii of stationary states (r) is expressed as:

$r = a_0 \frac{n^2}{z}$ . . . (ii)

From eqn (i) and (ii)

$n\lambda = \frac{2\pi a_0 n^2}{z}; \lambda = \frac{2\pi a_0 n}{z}$

$1.5\pi a_0 = 2\pi a_0 \frac{n}{z}$

$\frac{n}{z} = \frac{1.5}{2} = 0.75$

Question131

The de Broglie wavelength (λ) associated with a photoelectron varies with the frequency (v) of the incident radiation as, [v_0 is threshold frequency]:
[Jan. 11, 2019 (II)]

Options:

A. $\lambda \propto \frac{1}{(v - v_0)}$

B. $\lambda \propto \frac{1}{(v - v_0)^{\frac{1}{4}}}$

C. $\lambda \propto \frac{1}{(v - v_0)^{\frac{3}{2}}}$

D. $\lambda \propto \frac{1}{(v - v_0)^{\frac{1}{2}}}$

Answer: D

Solution:

Solution:
According to de-Broglie wavelength equation,
$\lambda = \frac{h}{mv} \Rightarrow \lambda \propto \frac{1}{v}$
According to photoelectric effect,
$hv - hv_0 = \frac{1}{2}mv^2; v - v_0 = \frac{1}{2} = \frac{mv^2}{h}$
$v - v_0 \propto v^2$
$v \propto (v - v_0)^{1/2}$
$\therefore \lambda \propto \frac{1}{(v - v_0)^{1/2}}$

Question132

Which of the following combination of statements is true regarding the interpretation of the atomic orbitals? [Jan. 9,2019 (II)|]

Options:

A. An electron in an orbital of high angular momentum stays away from the nucleus than an electron in the orbital of lower angular momentum.

B. For a given value of the principal quantum number, the size of the orbit is inversely proportional to the azimuthal quantum number.

C. According to wave mechanics, the ground state an- gular momentum is equal to $\frac{h}{2\pi}$

D. The plot of ψ vs r for various azimuthal quantum numbers, shows peak shifting towards higher r value.
(a) (a), (d) (b) (a), (b) (c) (a), (c) (d) (b), (c)

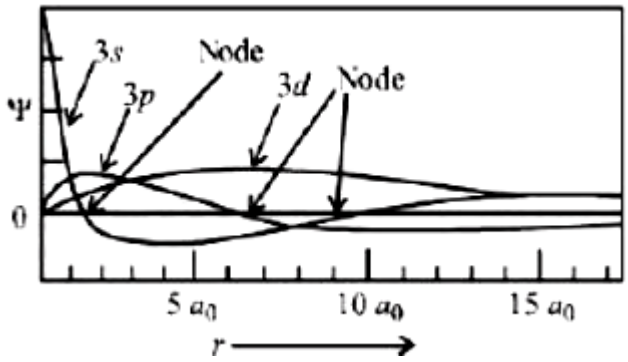
Answer: A

Solution:

Solution:
(a) Angular momentum (L) = $\frac{nh}{2\pi}$
Therefore, as n increases, L also increases.
(b) $r \propto \frac{n^2}{z}$

(c) For $n = 1, L = \frac{h}{2\pi}$

(d) As l increases, the peak of ψ vs r shifts towards higher ' r ' value.



Question133

Among the following, the energy or 2s or orbital is lowest in [April 12, 2019 (II)]

Options:

A. K

B. H

C. Li

D. Na

Answer: A

Solution:

Solution:
As the value of Z (atomic number) increases, energy of orbitals decreases (becomes more-ve value)
$\therefore$ Order of energy of $2s$ orbital is $H > Li > Na > K$

Question134

The ratio of the shortest wavelength of two spectral series of hydrogen spectrum is found to be about 9. The spectral series are : [April 10, 2019 (II)]

Options:

A. Lyman and Paschen

B. Balmer and Brackett

C. Brackett and Pfund

D. Paschen and Pfund

Answer: A

Solution:

Solution:
For determined shortest wavelength, $n_2 = \infty$

Lyman series $\bar{v}_L = \frac{1}{\lambda_L} = R\left[\frac{1}{(1)^2} - \frac{1}{\infty^2}\right]$

Paschen series $\bar{v}_P = \frac{1}{\lambda_P} = R\left[\frac{1}{(3)^2} - \frac{1}{\infty^2}\right]$

$\frac{\bar{v}_L}{\bar{v}_P} = \frac{\lambda_p}{\lambda_L} = 9$

Question135

For any given series of spectral lines of atomic hydrogen, let $\Delta\bar{v} = \bar{v}_{max} - \bar{v}_{min}$ be the difference in maximum and minimum frequencies in cm^{-1}. The ratio $\Delta\bar{v}_{Lyman} / \Delta\bar{v}_{Balmer\ i\ is}$: [April 9, 2019 (I)]

Options:

A. 4 : 1

B. 9 : 4

C. 5 : 4

D. 27 : 5

Answer: B

Solution:

Solution:

$\bar{v} \propto \Delta E$

For H-atom

$$\bar{v} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

For Lyman series,

$$\bar{v}(max) = 13.6\left(1 - \frac{1}{\infty}\right)$$

$$\bar{v}(min) = 13.6\left(1 - \frac{1}{4}\right)$$

$$\therefore \bar{v}_{max} - \bar{v}_{min} = 13.6\left(\frac{1}{4}\right)$$

For Balmer series,

$$\bar{v}(max) = 13.6\left(\frac{1}{4} - \frac{1}{\infty}\right)$$

$$\bar{v}(min) = 13.6\left(\frac{1}{4} - \frac{1}{9}\right)$$

$$\therefore \bar{v}_{max} - \bar{v}_{min} = 13.6\left(\frac{1}{9}\right)$$

So, $\frac{\Delta\bar{v}_{Lyman}}{\Delta\bar{v}_{Balmer}} = \frac{9}{4}$

Question136

Which one of the following about an electron occupying the 1s orbital in a hydrogen atom is incorrect? (The Bohr radius is represented by a_0).

[April 9, 2019 (II)]

Options:

A. The probability density of finding the electron is maximum at the nucleus.

B. The electron can be found at a distance $2a_0$ from the nucleus.

C. The magnitude of the potential energy is double that of its kinetic energy on an average.

D. The total energy of the electron is maximum when it is at a distance a_0 from the nucleus.

Answer: D

Solution:

Solution:
The total energy of the electron is minimum at a distance of a_0 from the nucleus for $1s$ orbital.

Question137

If p is the momentum of the fastest electron ejected from a metal surface after the irradiation of light having wavelength m, then for 1.5p momentum of the photoelectron, the wavelength of the light should be:
(Assume kinetic energy of cjected photoelectron to be very high in comparison to work function):
[April 8, 2019 (II)]

Options:

A. $\frac{3}{4}\lambda$

B. $\frac{1}{2}\lambda$

C. $\frac{2}{3}\lambda$

D. $\frac{4}{9}\lambda$

Answer: D

Solution:

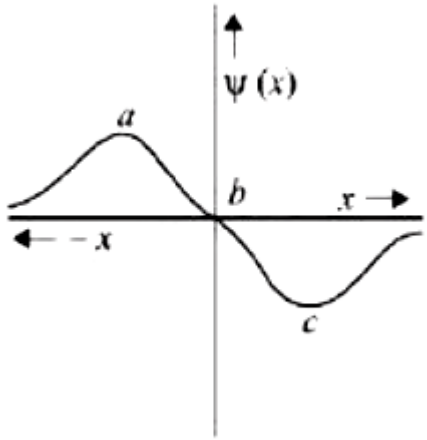
Solution:
In photoelectric effect,
$\frac{hc}{\lambda} = w + KE$ of electron
Given that KE of ejected photoelectron is very high in comparison to work function w.
$\frac{hc}{\lambda} = KE$
$\frac{hc}{\lambda} = \frac{1}{2}mv^2\left(\frac{m}{m}\right)$
$\frac{hc}{\lambda} = \frac{1}{2}.\frac{m^2v^2}{m}$
$\frac{hc}{\lambda} = \frac{P^2}{2m}$

New wavelength

$$\frac{hc}{\lambda_1} = \frac{(1.5P)^2}{2m} \Rightarrow \lambda_1 = \frac{4}{9}\lambda$$

Question138

The electrons are more likely to be found:



[April 12, 2019 (I)]

Options:

A. in the region a and c

B. in the region a and b

C. only in the region a

D. only in the region 0

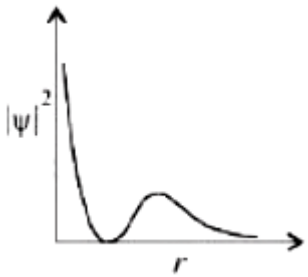
Answer: A

Solution:

Solution:
Probability of finding an electron will have maximum value at both 'a' and 'c'. There is zero probability of finding an electron at 'b'.

Question139

The graph between $|\psi|^2$ and r (radial distance) is shown below. This represents :



[April 10, 2019 (I)]

Options:

A. 3s orbital

B. 2s orbital

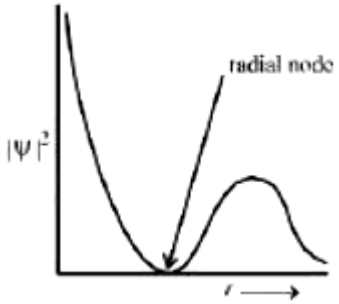
C. 1s orbital

D. 2p orbital

Answer: B

Solution:

Solution:
The given probability density curve is for 2s orbital due to the presence of only one radial node. 1s and 2p orbital do not have any radial node and 3s orbital has two radial nodes. Hence, option (b) is correct.



Question140

The isoelectronic set of ions is
[April 10, 2019 (I)]

Options:

A. N^{3-}, O^{2-}, F^{-} and Na^{+}

B. N^{3-}, Li^{+}, Mg^{2+} and O^{2-}

C. F^{-}, Li^{+}, Na^{+} and Mg^{2+}

D. Li^{+}, Na^{+}, O^{2-} and F^{-}

Answer: A

Solution:

Solution:
Atomic numbers of N, O, F and Na are 7, 8, 9 and 11 respectively. Therefore, total number of electrons in each of N^{3-}, O^{2}, F^{-}, and Na^{+} are 10 and hence they are isoelectronic.

Question141

The quantum number of four electrons are given below:

I. $n = 4, l = 2, m_l = -2, m_s = -1/2$

II. $n = 3, l = 2, m_l = 1, m_s = +1/2$

III. $n = 4, l = 1, m_l = 0, m_s = +1/2$

IV. $n = 3, l = 1, m_l = 1, m_s = -1/2$

The correct order of their increasing energies will be:
[April 8, 2019(I)]

Options:

A. IV < III < II < I

B. I < II < III < IV

C. IV < II < III < I

D. I < III < II < IV

Answer: C

Solution:

Solution:

				$n+l$
(I)	$n=4$	$l+2$	$4d$	6
(II)	$n=3$	$l+2$	$3d$	5
(III)	$n=4$	$l+1$	$4p$	5
(IV)	$n=3$	$l+1$	$3p$	4

The energy of an atomic orbital increases with increasing $n+\ell$. For identical values of $n+\ell$, energy increases with increasing value of n. Therefore the correct order of energy is:

Question142

The size of the iso-electronic species Cl^-, Ar and Ca^{2+} is affected by: [April 8, 2019 (I)]

Options:

A. azimuthal quantum number of valence shell

B. electron-electron interaction in the outer orbitals

C. principal quantum number of valence shell

D. nuclear charge

Answer: D

Solution:

Solution:
Iso-electronic species differ in size due to different effective nuclear charge.

Question143

Which of the following statements is false?
[Online April 16, 2018]

Options:

A. Splitting of spectral lines in electrical field is called Stark effect

B. Frequency of emitted radiation from a black body goes from a lower wavelength to higher wavelength as the temperature increases

C. Photon has momentum as well as wavelength

D. Rydberg constant has unit of energy

Answer: B

Solution:

Solution:
When temperature is increased, black body emits high energy radiation from higher wavelength to lower wavelength.

Question144

Ejection of the photoelectron from metal in the photoelectric effect experiment can be stopped by applying 0.5V when the radiation of 250nm is used. The work function of the metal is:
[Online April 15, 2018 (I)]

Options:

A. 4eV

B. 5.5eV

C. 4.5eV

D. 5eV

Answer: C

Solution:

Solution:

$\lambda = 250nm$

$E = \frac{hc}{\lambda} = \frac{1240eV \cdot nm}{250nm} = 4.96eV$

$KE = \text{stopping potential} = 0.5eV$

$E = W_0 + K.E$

$4.96 = W_0 + 0.5$

$W_0 = 4.46 \approx 4.5eV$

Question145

The de-Broglie's wavelength of electron present in first Bohr orbit of 'H' atom is:
[Online April 15, 2018 (II)]

Options:

A. $4 \times 0.529Å$

B. $2\pi \times 0.529Å$

C. $\frac{0.529}{2\pi}Å$

D. 0.529A

Answer: B

Solution:

Solution:
First Bohr orbit of H atom has radius $r = 0.529Å$ Also, the angular momentum is quantised.

$mvr = \frac{h}{2\pi}$

$2\pi r = \frac{h}{mV} = \lambda$

$\therefore \lambda = 2\pi \times 0.529Å$

Question146

The radius of the second Bohr orbit for hydrogen atom is:
(Plank's const. $h = 6.6262 \times 10^{-34}$ J s; mass of electron $= 9.1091 \times 10^{-31}$kg; charge of electron $e = 1.60210 \times 10^{-19}$C;

permittivity of vaccum $E_0 = 8.854185 \times 10^{-12} kg^{-1} m^{-3} A^2$)
[2017]

Options:

A. 1.65Å

B. 4.76Å

C. 0.529Å

D. 2.12Å

Answer: D

Solution:

Solution:
Radius of n^{th} Bohr orbit in H-atom $= 0.53n^2$Å
Radius of II Bohr orbit $= 0.53 \times (2)^2 = 2.12$Å

Question147

If the shortest wavelength in Lyman series of hydrogen atom is A, then the longest wavelength in Paschen series of He^+ is :
[Online April 8,2017]

Options:

A. $\frac{5A}{9}$

B. $\frac{9A}{5}$

C. $\frac{36A}{5}$

D. $\frac{36A}{7}$

Answer: D

Solution:

Solution:
For Lyman series (shortest wavelength)
$n_1 = 1, n_2 = \infty$

$$\frac{1}{\lambda} = RZ^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$\Rightarrow \frac{1}{A} = 1^2R\left(\frac{1}{1} - \frac{1}{\infty}\right) \Rightarrow \frac{1}{A} = R$$

Longest wavelength $= 1^{st}$ line
$n_1 = 3, n_2 = 4$

$$\frac{1}{\lambda} = RZ^2\left(\frac{1}{3^2} - \frac{1}{4^2}\right) \Rightarrow \frac{1}{\lambda} = \frac{R7}{36}$$

$$R = \frac{1}{A}$$

$$\frac{1}{\lambda} = \frac{\frac{1}{A} \times 7}{36} \Rightarrow \frac{1}{\lambda} = \frac{7}{36A} \Rightarrow \lambda = \frac{36A}{7}$$

Question148

The electron in the hydrogen atom undergoes transition from higher orbitals to orbital of radius 211.6pm. This transition is associated with :
[Online April 9, 2017]

Options:

A. Lyman series

B. Balmer series

C. Paschen series

D. Brackett serics

Answer: B

Solution:

Solution:

$$r = 0.529 \times \frac{n^2}{Z}\text{Å}$$

$r = 211.6\text{pm} = 2.11\text{Å}$

$$\Rightarrow 0.529 \times \frac{n^2}{Z} = 2.11\text{Å}$$

$n = 2$ (Balmer series)

Question149

A stream of electrons from a heated filaments was passed two charged plates kept at a potential difference V esu. If 'e' and m are charge and mass of an electron, respectively, then the value of h/λ (where λ is wavelength associated with electron wave) is given by: [2016]

Options:

A. $\sqrt{meV}$

B. $\sqrt{2meV}$

C. meV

D. 2meV

Answer: B

Solution:

Solution:
As electron of charge 'e' is passed through 'V' volt, kinetic energy of electron will be eV

Wavelength of electron wave $(\lambda) = \frac{h}{\sqrt{2m \cdot K \cdot E}}$

$\lambda = \frac{h}{\sqrt{2meV}} \quad \therefore \frac{h}{\lambda} = \sqrt{2meV}$

Question150

The total number of orbitals associated with the principal quantum number 5 is:
[Online April 9,2016]

Options:

A. 20

B. 25

C. 10

D. 5

Answer: B

Solution:

Solution:
Number of orbitals in a shell $= n^2 = (5)^2 = 25.$

Question151

Which of the following is the energy of a possible excited state of hydrogen?
[2015]

Options:

A. $-3.4eV$

B. $+6.8eV$

C. $+13.6eV$

D. $-6.8eV$

Answer: A

Solution:

Solution:
Total energy $= -\frac{13.6}{n^2}Z^2 eV$
where $n = 2, 3, 4....$
Putting $n = 2$
$E_T = -\frac{13.6}{4} = -3.4eV$

Question152

At temperature T , the average kinetic energy of any particle is $\frac{3}{2}kT$. The de Broglie wavelength follows the order : [Online April 11, 2015]

Options:

A. Visible photon > Thermal neutron > Thermal electron

B. Thermal proton > Thermal electron > Visible photon

C. Thermal proton > Visible photon > Thermal electron

D. Visible photon > Thermal electron > Thermal neutron

Answer: D

Solution:

Solution:

Kinetic energy of any particle $= \frac{3}{2}kT$

Also $K.E. = \frac{1}{2}mv^2$

$\frac{1}{2}mv^2 = \frac{3}{2}kT \Rightarrow v^2 = \frac{3kT}{m}$

$v = \sqrt{\frac{3kT}{m}}$

de-broglie wavelength $= \lambda = \frac{h}{mv} = \frac{h}{m\sqrt{\frac{3kT}{m}}}$

$\lambda = \frac{h}{\sqrt{3kT\,m}}; \lambda \propto \frac{1}{\sqrt{m}}$

Mass of electron < mass of neutron λ (electron) $>\lambda$ (neutron)

Question153

If the principal quantum number n = 6, the correct sequence of filling of electrons will be: [Online April 10,2015]

Options:

A. $ns \rightarrow (n-2)f \rightarrow np \rightarrow (n-1)d$

B. $ns \rightarrow (n-2)f \rightarrow (n-1)d \rightarrow np$

C. $ns \rightarrow np \rightarrow (n-1)d \rightarrow (n-2)f$

D. $ns \rightarrow (n-1)d \rightarrow (n-2)f \rightarrow np$

Answer: B

Solution:

Solution:
According to Aufbau principle, the sequence of filling electrons in sixth period is
$6s - 4f - 5d - 6p$ i.e., $(ns) \rightarrow (n-2)f \rightarrow (n-1)d \rightarrow np$

Question154

If λ_0 and λ be threshold wavelength and wavelength of incident light, the velocity of photoelectron ejected from the metal surface is: [Online April 11,2014]

Options:

A. $\sqrt{\frac{2h}{m}(\lambda_0 - \lambda)}$

B. $\sqrt{\frac{2hc}{m}(\lambda_0 - \lambda)}$

C. $\sqrt{\frac{2hc}{m}\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)}$

D. $\sqrt{\frac{2h}{m}\left(\frac{1}{\lambda_0} - \frac{1}{\lambda}\right)}$

Answer: C

Solution:

Solution:
The kinetic energy of the ejected electron is given by the equation
$h\nu = h\nu_0 + \frac{1}{2}mv^2 \quad \because v = \frac{c}{\lambda}$
or $\frac{hc}{\lambda} = \frac{hc}{\lambda_0} + \frac{1}{2}mv^2$

$$\frac{1}{2}mv^2 = \frac{hc}{\lambda} - \frac{hc}{\lambda_0} = hc\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)$$

$$\therefore\ v^2 = \frac{2hc}{m}\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)$$

$$\text{or}\quad v = \sqrt{\frac{2hc}{m}\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)}$$

Question155

The energy of an electron in first Bohr orbit of H-atom is 13.6eV . The energy value of electron in the excited state of Li^{2+} is: [Online April 9, 2014]

Options:

A. −27.2eV

B. 30.6eV

C. −30.6eV

D. 27.2eV

Answer: C

Solution:

Solution:
For Li^{2+} ion

$$E = -13.6 \times \frac{Z^2}{n^2}eV = -13.6 \times \frac{(3)^2}{(2)^2}$$

$$= \frac{-13.6 \times 9}{4} = -30.6eV$$

Question156

Based on the equation:

[Online April 11,2014] $\Delta E = -2.0 \times 10^{-18} J \left(\frac{1}{n_2^2} - \frac{1}{n_1^2} \right)$ **the wavelength of the light that must be absorbed to excite hydrogen electron from level n = 1 to level n = 2 will be:**
($h = 6.625 \times 10^{-34} J\,s$, $C = 3 \times 10^{8} ms^{-1}$)
[Online April 11, 2014]

Options:

A. $1.325 \times 10^{-7} m$

B. $1.325 \times 10^{-10} m$

C. $2.650 \times 10^{-7} m$

D. $5.300 \times 10^{-10} m$

Answer: A

Solution:

Solution:

$$\Delta E = -2.0 \times 10^{-18} \times \left(\frac{1}{2^2} - \frac{1}{1^2} \right)$$

$$= -2.0 \times 10^{-18} \times \frac{-3}{4}$$

$$= 1.5 \times 10^{-18} J$$

$$\Delta E = \frac{hc}{\lambda}$$

$$\lambda = \frac{hc}{\Delta E} = \frac{6.625 \times 10^{-34} js \times 3 \times 10^{8} ms^{-1}}{1.5 \times 10^{-18} J}$$

$$= 1.325 \times 10^{-7} m$$

Question157

If m and e are the mass and charge of the revolving electron in the orbit of radius r for hydrogen atom, the total energy of the revolving electron will be:
[Online April 12,2014]

Options:

A. $\frac{1}{2}\frac{e^2}{r}$

B. $-\frac{e^2}{r}$

C. $\frac{me^2}{r}$

D. $-\frac{1}{2}\frac{e^2}{r}$

Answer: D

Solution:

Solution:
Total energy of a revolving electron is the sum of its kinetic and potential energy.
Total energy $= K.E. + P.E$
$= \frac{e^2}{2r} + \left(-\frac{e^2}{r}\right);\ = -\frac{e^2}{2r}$

Question158

Excited hydrogen atom emits light in the ultraviolet region at 2.47×10^{15}H z. With this frequency, the energy of a single photon is: ($h = 6.63 \times 10^{-34}$J s)
[Online April 12, 2014]

Options:

A. 8.041×10^{-40}J

B. 2.680×10^{-19}J

C. 1.640×10^{-18}J

D. 6.111×10^{-17}J

Answer: C

Solution:

Solution:

$E = hv$
$= 6.63 \times 10^{-34} \times 2.47 \times 10^{15}$
$= 1.640 \times 10^{-18} J$

Question159

Ionization cnergy of gaseous N a atoms is 495.5kJ mol $^{-1}$. The lowest possible frequency of light that ionizes a sodium atom is ($h = 6.626 \times 10^{-34} J\ s$, $N_A = 6.022 \times 10^{23} mol^{-1}$) [Online April 19,2014]

Options:

A. $7.50 \times 10^{4} s^{-1}$

B. $4.76 \times 10^{14} s^{-1}$

C. $3.15 \times 10^{15} s^{-1}$

D. $1.24 \times 10^{15} s^{-1}$

Answer: D

Solution:

Solution:
Energy $= N_A hv$
$495.5 = 6.023 \times 10^{23} \times 6.6 \times 10^{-34} \times v$
$v = \frac{495.5 \times 10^{3} J}{6.023 \times 10^{23} \times 6.6 \times 10^{-34}} = 12.4 \times 10^{14}$
$= 1.24 \times 10^{15} s^{-1}$

Question160

The de-Broglie wavelength of a particle of mass 6.63g moving with a velocity of 100ms^{-1} is: [Online April 12, 2014]

Options:

A. 10^{-33}m

B. 10^{-35}m

C. 10^{-31}m

D. 10^{-25}m

Answer: A

Solution:

Solution:

de $(\lambda) = \frac{h}{mv}$

$= \frac{6.63 \times 10^{-34} \text{J s}}{6.63 \times 10^{-3} \text{kg} \times 100 \text{m/s}} = 10^{-33}$m

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Question161

The correct set of four quantum numbers for the valence electrons of rubidium atom (Z = 37) is:
[2014]

Options:

A. $5, 0, 0, +\frac{1}{2}$

B. $5, 1, 0, +\frac{1}{2}$

C. $5, 1, 1, +\frac{1}{2}$

D. $5, 0, 1, +\frac{1}{2}$

Answer: A

Solution:

Solution:

The electronic configuration of Rubidium (Rb = 37) is

$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s^1$

Since last electron enters in 5s orbital

Hence $n = 5, l = 0, m = 0, s = \pm \frac{1}{2}$

Question162

Energy of an electron is given by $E = -2.178 \times 10^{-18} J \left(\frac{Z^2}{n^2} \right)$

Wavelength of light required to excite an electron in an hydrogen atom from level n = 1 to n = 2 will be:

($h = 6.62 \times 10^{-34} J\ s$ and $c = 3.0 \times 10^{8} ms^{-1}$)

[2013]

Options:

A. $1.214 \times 10^{-7} m$

B. $2.816 \times 10^{-7} m$

C. $6.500 \times 10^{-7} m$

D. $8.500 \times 10^{-7} m$

Answer: A

Solution:

Solution:

$$\Delta E = 2.178 \times 10^{-18} \left(\frac{1}{1^2} - \frac{1}{2^2} \right) = \frac{hc}{\lambda}$$

$$\Rightarrow 2.178 \times 10^{-18} \times \frac{3}{4} = \frac{hc}{\lambda}$$

$$= \frac{6.62 \times 10^{-34} \times 3 \times 10^{8}}{\lambda}$$

$$\lambda = \frac{6.62 \times 10^{-34} \times 3 \times 10^{8} \times 4}{2.178 \times 10^{-18} \times 3}$$

$$= 1.214 \times 10^{-7} m$$

Question163

The wave number of the first emission line in the Balmer series of H-Spectrum is:
(R = Rydberg constant):
[Online April 22, 2013]

Options:

A. $\frac{5}{36}R$

B. $\frac{9}{400}R$

C. $\frac{7}{6}R$

D. $\frac{3}{4}R$

Answer: A

Solution:

Solution:

$$\bar{v} = RZ^2\left(\frac{1}{2^2} - \frac{1}{3^2}\right)$$

$$= R\left(\frac{1}{4} - \frac{1}{9}\right) = \frac{5R}{36}$$

Question164

The de Broglie wavelength of a car of mass 1000kg and velocity 36 km/hr is :
[Online April 23, 2013]

Options:

A. 6.626×10^{-34}m

B. 6.626×10^{-38}m

C. 6.626×10^{-31}m

D. 6.626×10^{-30}m

Answer: B

Solution:

Solution:

$\lambda = \frac{h}{mv}$

$h = 6,6 \times 10^{-34} J\ s$

$m = 1000kg$

$v = 36km/hr = \frac{36 \times 10^3}{60 \times 60} m/sec = 10m/sec$

$\therefore\ \lambda = \frac{6.6 \times 10^{-34}}{10^3 \times 10} = 6.6 \times 10^{-38} m$

Question165

In an atom how many orbital(s) will have the quantum numbers; $n = 3, l = 2$ and $m_l = +2$?

[Online April 9, 2013]

Options:

A. 5

B. 3

C. 1

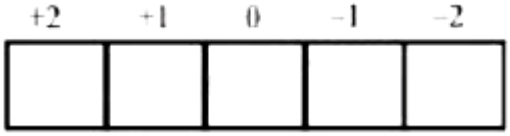
D. 7

Answer: C

Solution:

Solution:

$n = 3, l = 2$ means 3d orbital



i.e. in an atom only one orbital can have the value $m_l = +2$

Question166

Given
(A) n = 5, m = +1
(B) n = 2, ℓ = 1, $m_f = -1$, $m_s = -1/2$
The maximum number of electron(s) in an atom that can have the quantum numbers as given in (A) and (B) are respectively:
[Online April 25, 2013]

Options:

A. 25 and 1

B. 8 and 1

C. 2 and 4

D. 4 and 1

Answer: B

Solution:

Solution:
(i) $n = 5$ means $l = 0, 1, 2, 3, 4$
since $m = +1$
hence total no. of electrons will be
$= 0(\text{ from s}) + 2(\text{ from p}) + 2(\text{ from d}) + 2(\text{ from f}) + 2(\text{ from g})$
$= 0 + 2 + 2 + 2 + 2 = 8$
(ii) $n = 2, l = 1, m_l = -1, m_s = -1/2$ represent 2p orbital with one electron.

Question167

The limiting line in Balmer series will have a frequency of (Rydberg constant, $R_\infty = 3.29 \times 10^{15}$ cycles/s)
[Online May 7,2012]

Options:

A. $8.22 \times 10^{14} s^{-1}$

B. $3.29 \times 10^{15} s^{-1}$

C. $3.65 \times 10^{14} s^{-1}$

D. $5.26 \times 10^{13} s^{-1}$

Answer: A

Solution:

Solution:

$v = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) Hz$

$v = 3.29 \times 10^{15}\left(\frac{1}{2^2} - \frac{1}{\infty^2}\right)$

$= 8.22 \times 10^{14} s^{-1}$

Question168

If the radius of first orbit of H atom is a_0, the de-Broglie wavelength of an electron in the third orbit is [Online May 12, 2012]

Options:

A. $4\pi a_0$

B. $8\pi a_0$

C. $6\pi a_0$

D. $2\pi a_0$

Answer: C

Solution:

Solution:

$r_n = a_0 n^2$

$r = a_0 \times (3)^2 = 9a_0$

$mvr = \frac{nh}{2\pi}; mv = \frac{nh}{2\pi r} = \frac{3h}{2\pi \times 9a_0} = \frac{h}{6\pi a_0}$

$\lambda = \frac{h}{mv} = \frac{n}{h} \times 6\pi a_0 = 6\pi a_0$

Question169

If the kinetic energy of an electron is increased four times, the wavelength of the de-Broglie wave associated with it would become [Online May 19, 2012]

Options:

A. one fourth

B. half

C. four times

D. two times

Answer: B

Solution:

Solution:
de − Broglie wavelength is given by:

$\lambda = \frac{h}{mv}$ . . . (i)

$K.E. = \frac{1}{2}mv^2$

$v^2 = \frac{2K \cdot E}{m}$

$v = \sqrt{\frac{2K \cdot E}{m}}$

Substituting this in equation (i)

$\lambda = \frac{h}{m}\sqrt{\frac{m}{2K \cdot E}}$

$\lambda = h\sqrt{\frac{1}{2m(K \cdot E)}}$

i.e. $\lambda \propto \frac{1}{\sqrt{K \cdot E}}$

$\therefore$ when KE become 4 times wavelength become $1/2$.

Question170

The electrons identified by quantum numbers n and ℓ :
(A) n = 4, l = 1
(B) n = 4, l = 0

(C) n = 3, l = 2
(D) n = 3, l = 1
can be placed in order of increasing energy as:
[2012]

Options:

A. (C) < (D) < (B) < (A)

B. (D) < (B) < (C) < (A)

C. (B) < (D) < (A) < (C)

D. (A) < (C) < (B) < (D)

Answer: B

Solution:

Solution:
(A)4p (B) 4s
(C) 3d (D) 3p Accroding to Bohr Bury's $(n+l)$ rule, increasing order of energy (D) < (B) < (C) < (A).
Note: If the two orbitals have same value of $(n+l)$ then the orbital with lower value of n will be filled first.

Question171

The increasing order of the ionic radii of the given iscelectronic species is :
[2012]

Options:

A. Cl, Ca^{2+}, K^{+}, S^{2}

B. S^{2}, Cl^{-}, Ca^{2+}, K^{+}

C. Ca^{2+}, K^{+}, Cl^{-}, S^{2}

D. K^{+}, S^{2}, Ca^{2+}, Cl^{-}

Answer: C

Solution:

Solution:
Among isoelectronic species ionic radii increases as the negatives charge increases.
Order of ionic radii $Ca^{2+} < K^{+} < Cl^{-} < S^{2-}$
The number of electrons remains the same but nuclear charge increases with increase in the atomic number causing decrease in size.

Question172

The following sets of quantum numbers represent four electrons in an atom.
(i) n = 4, l = 1
(ii) n = 4, l = 0
(iii) n = 3, l = 2
(iv) n = 3, l = 1
The sequence representing increasing order of energy, is [Online May 26, 2012]

Options:

A. (iii) < (i) < (iv) < (ii)

B. (iv < (ii) < (iii) < (i)

C. (i) < (iii) < (ii) < (iv)

D. (ii) < (iv) < (i) < (iii)

Answer: B

Solution:

Solution:
(i) 4p (ii) 4s
(iii) 3d (iv) 3p
According to Bohr Bury's $(n+l)$ rule, increasing order of energy will be (iv) <(ii) < (iii) < (i).
Note: If the two orbitals have same value of $(n+l)$ then the orbital with lower value of n will be filled first.

Question173

The frequency of light emitted for the transition n = 4 to n = 2 of the He^+ is equal to the transition in H atom corresponding to which of the following ?
[2011RS]

Options:

A. n = 2 to n = 1

B. n = 3 to n = 2

C. n = 4 to n = 3

D. n = 3 to n = 1

Answer: A

Solution:

Solution:
For He^+,

$$v = RZ^2\left(\frac{1}{2^2} - \frac{1}{4^2}\right)Hz$$

For H,

$$v = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)Hz$$

For same frequency,

$$Z^2\left(\frac{1}{2^2} - \frac{1}{4^2}\right) = \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

Since, $Z = 2$

$$\therefore \quad \frac{1}{n_1^2} - \frac{1}{n_2^2} = \frac{1}{1^2} - \frac{1}{2^2}$$

$\therefore n_1 = 1$ & $n_2 = 2$

Question174

The energy required to break one mole of $Cl - Cl$ bonds in Cl_2 is 242kJ mol^{-1}. The longest wavelength of light capable of breaking a single $Cl - Cl$ bond is

$(c = 3 \times 10^8 ms^{-1}$ and $N_A = 6.02 \times 10^{23} mol^{-1})$
[2010]

Options:

A. 594nm

B. 640nm

C. 700nm

D. 494nm

Answer: D

Solution:

Solution:
Energyrequired to break single $Cl - Cl$ bond

$$= \frac{242 \times 10^3}{6.023 \times 10^{23}} = \frac{hc}{\lambda}$$

$$= \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{\lambda}$$

$$\therefore \lambda = \frac{6.626 \times 10^{-34} \times 3 \times 10^8 \times 6.023 \times 10^{23}}{242 \times 10^3}$$

$$= 0.4947 \times 10^{-6} m = 494.7nm$$

Question175

Ionisation energy of He^+ is $19.6 \times 10^{-18} J$ atom $^{-1}$. The energy of the first stationary state (n = 1) of Li^{2+} is
[2010]

Options:

A. $4.41 \times 10^{-16} J$ atom $^{-1}$

B. $-4.41 \times 10^{-17} J$ atom $^{-1}$

C. $-2.2 \times 10^{-15} J$ atom $^{-1}$

D. $8.82 \times 10^{-17} J$ atom $^{-1}$

Answer: B

Solution:

Solution:

I. $E = \frac{Z^2}{n^2} \times 13.6eV$

or $\frac{I_1}{I_2} = \frac{Z_1^2}{n_1^2} \times \frac{n_2^2}{Z_2^2}$

Given $I_1 = -19.6 \times 10^{-18} J/atom$, $Z_1 = 2$,

$n_1 = 1, Z_2 = 3$ and $n_2 = 1$

Substituting these values in equation (ii).

$-\frac{19.6 \times 10^{-18}}{I_2} = \frac{4}{1} \times \frac{1}{9}$

or $I_2 = -19.6 \times 10^{-18} \times \frac{9}{4}$

$= -4.41 \times 10^{-17} J/atom$

Question176

Calculate the wavelength (in nanometer) associated with a proton moving at $1.0 \times 10^3 ms^{-1}$. (Mass of proton $= 1.67 \times 10^{-27} kg$ and $h = 6.63 \times 10^{-34} J\,s$) [2009]

Options:

A. 0.40nm

B. 2.5nm

C. 14.0nm

D. 0.32nm

Answer: A

Solution:

Solution:

$\lambda = \frac{h}{mv} = \frac{6.63 \times 10^{-34}}{1.67 \times 10^{-27} \times 1 \times 10^3}$

$= 3.97 \times 10^{-10} m = 0.397nm.$

Question177

In an atom, an electron is moving with a speed of 600m/s with an accuracy of 0.005%. Certainity with which the position of the electron can be located is ($h = 6.6 \times 10^{-34}$ kgm^2s^{-1}, mass of electron, $e_m = 9.1 \times 10^{-31}kg$):
[2009]

Options:

A. $5.10 \times 10^{-3}m$

B. $1.92 \times 10^{-3}m$

C. $3.84 \times 10^{-3}m$

D. $1.52 \times 10^{-4}m$

Answer: B

Solution:

Solution:
According to Heisenberg uncertainty principle.

$\Delta x m \Delta v = \frac{h}{4\pi}; \Delta x = \frac{h}{4\pi m \Delta v}$

Here $\Delta v = \frac{600 \times 0.005}{100} = 0.03 m/s$

So,

$$\Delta x = \frac{6.6 \times 10^{-34}}{4 \times 3.14 \times 9.1 \times 10^{-31} \times 0.03}$$
$$= 1.92 \times 10^{-3}m$$

Question178

The ionization enthalpy of hydrogen atom is $1.312 \times 10^6 J\ mol^{-1}$. The energy required to excite the electron in the atom from n = 1 to n = 2 is
[2008]

Options:

A. $8.51 \times 10^5 \text{J mol}^{-1}$

B. $6.56 \times 10^5 \text{J mol}^{-1}$

C. $7.56 \times 10^5 \text{J mol}^{-1}$

D. $9.84 \times 10^5 \text{J mol}^{-1}$

Answer: D

Solution:

Solution:
(ΔE), The energy required to excite an electron in an atom of hydrogen from $n = 1$ to $n = 2$ is ΔE (difference in energy E_2 and E_1)
Values of E_2 and E_1 are,

$$E_2 = \frac{-1.312 \times 10^6 \times (1)^2}{(2)^2} = -3.28 \times 10^5 \text{J mol}^{-1}$$

ΔE is given by the relation,

$$E_1 = -1.312 \times 10^6 \text{J mol}^{-1}$$

$$\therefore \Delta E = E_2 - E_1 = [-3.28 \times 10^5] - [-1.312 \times 10^6] \text{J mol}^{-1}$$

$$= (-3.28 \times 10^5 + 1.312 \times 10^6) \text{J mol}^{-1}$$

$$= 9.84 \times 10^5 \text{J mol}^{-1}$$

Question179

Which one of the following constitutes a group of the isoelectronic species?
[2008]

Options:

A. C_2^{2-}, O_2^-, CO, NO

B. $NO^+, C_2^{2-}, CN^-, N_2$

C. $CN^-, N_2, O_2^{2-}, C_2^{2-}$

D. N_2, O_2^-, NO^+, CO

Answer: B

Solution:

Solution:
Species having same number of electrons are isoelectronic. On calculating the number of electrons in each species given here, we get.
$CN^{-}(6+7+1=14)$; $N_2(7+7=14)$
$O_2^{2-}(8+8+2=18)$; $C_2^{2}(6+6+2=14)$
$O_2^{-}(8+8+1=17)$; $NO^{+}(7+8-1=14)$
$CO(6+8=14)$; $NO(7+8=15)$
From the above calculation we find that all the species listed in choice (b) have 14 electrons each so it is the correct answer.

Question180

Which of the following sets of quantum numbers represents the highest energy of an atom?
[2007]

Options:

A. $n=3, l=0, m=0, s=+\frac{1}{2}$

B. $n=3, l=1, m=1, s=+\frac{1}{2}$

C. $n=3, l=2, m=1, s=+\frac{1}{2}$

D. $n=4, l=0, m=0, s=+\frac{1}{2}$.

Answer: C

Solution:

Solution:
(a) $n=3, l=0$ means $3s$ -orbital and $n+l=3$
(b) $n=3, l=1$ means $3p$ -orbital $n+l=4$
(c) $n=3, l=2$ means $3d$ -orbital $n+l=5$
(d) $n=4, l=0$ means $4s$ -orbital $n+l=4$
Increasing order of energy among these orbitals is
$3s<3p<4s<3d$
$\therefore 3d$ has highest energy.

Question181

According to Bohr's theory, the angular momentum of an electron in 5^{th} orbit is
[2006]

Options:

A. $10h/\pi$

B. $2.5h/\pi$

C. $25h/\pi$

D. $1.0h/\pi$

Answer: B

Solution:

Solution:
Angular momentum of an electron in n^{th} orbital is given by, $mvr = \frac{nh}{2\pi}$
For $n = 5$, we have
Angular momentum of electron $= \frac{5h}{2\pi} = \frac{2.5h}{\pi}$

Question182

Uncertainty in the position of an electron (mass $= 9.1 \times 10^{-31}$kg) moving with a velocity 300ms^{-1}, accurate upto 0.001% will be ($h = 6.63 \times 10^{-34}$J s)
[2006]

Options:

A. 1.92×10^{-2}m

B. 3.84×10^{-2}m

C. 19.2×10^{-2}m

D. 5.76×10^{-2}m

Answer: A

Solution:

Solution:
Given $m = 9.1 \times 10^{-31}$kg
$h = 6.6 \times 10^{-34}$J s
$\Delta v = \frac{300 \times .001}{100} = 0.003 ms^{-1}$
From Heisenberg's uncertainity principle
$\Delta x = \frac{6.62 \times 10^{-34}}{4 \times 3.14 \times 0.003 \times 9.1 \times 10^{-31}}$
$= 1.92 \times 10^{-2}$m

Question183

Which one of the following sets of ions represents a collection of isoelectronic species?
[2006]

Options:

A. $N^{3-}, O^{2-}, F^{-}, S^{2}$

B. $Li^{+}, Na^{+}, Mg^{2+}, Ca^{2+}$

C. $K^{+}, Cl^{-}, Ca^{2+}, Sc^{3+}$

D. $Ba^{2+}, Sr^{2+}, K^{+}, Ca^{2+}$

Answer: C

Solution:

Solution:
(a) $N^{3-} = 7 + 3 = 10e^{-}$, $O^{2-} \longrightarrow 8 + 2 = 10c^{-}$
$F^{-} = 9 + 1 = 10c^{-}$, $S^{2-} \longrightarrow 16 + 2 = 18e^{-}$
(not isoelectronic)
(b) $Li^{+} = 3 - 1 = 2e$, $Na^{+} = 11 - 1 = 10e^{-}$
$Mg^{2+} = 12 - 2 = 10e^{-}$

$Ca^{2+} = 20 - 2 = 18c^{-}$
(not isoelectronic)
(c) $K^{+} = 19 - 1 = 18e^{-}$, $Cl^{-} = 17 + 1 = 18e^{-}$
$Ca^{2+} = 20 - 2 = 18e^{-}$, $Sc^{3+} = 21 - 3 = 18e^{-}$
(isoelectronic)
(d) $Ba^{2+} = 56 - 2 = 54e^{-}$, $Sr^{2+} = 38 - 2 = 36e^{-}$
$K^{+} = 19 - 1 = 18e^{-}$, $Ca^{2+} = 20 - 2 = 18e^{-}$
(not isoelectronic)

Question184

Of the following sets which one does NOT contain isoelectronic species?
[2005]

Options:

A. BO_3^{3-}, CO_3^{2-}, NO_3^{-}

B. SO_3^{2-}, CO_3^{2-}, NO_3^{-}

C. CN^{-}, N_2, C_2^{2-}

D. PO_4^{3-}, SO_4^{2-}, ClO_4^{-}

Answer: B

Solution:

Solution:

Question185

In a multi-electron atom, which of the following orbitals described by the three quantum members will have the same energy in the absence of magnetic and electric fields?
(A) n = 1, l = 0, m = 0
(B) n = 2, l = 0, m = 0
(C) n = 2, l = 1, m = 1

(D) n = 3, l = 2, m = 1
(E) n = 3, l = 2, m = 0
[2005]

Options:

A. (D) and (E)

B. (C) and (D)

C. (B) and (C)

D. (A) and (B)

Answer: A

Solution:

Solution:
The energy of an orbital is given by $(n+l)$ rule. $(n+l)$ value for option (E) and (D) is $(3+2)=5$ hence they will have same energy, since their n values are also same.

Question186

The wavelength of the radiation emitted, when in a hydrogen atom electron falls from infinity to stationary state 1, would be (Rydberg constant $= 1.097 \times 10^{7} m^{-1}$)
[2004]

Options:

A. 406nm

B. 192nm

C. 91nm

D. 9.1×10^{-8}nm

Answer: C

Solution:

Solution:

$$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$\frac{1}{\lambda} = 1.097 \times 10^7\left(\frac{1}{1} - \frac{1}{\infty}\right) = 1.097 \times 10^7$$

$$\lambda = 91.15 \times 10^{-9}\text{m} \approx 91\text{nm}$$

Question187

Which of the following sets of quantum numbers is correct for an electron in 4f orbital ?
[2004]

Options:

A. $n = 4, l = 3, m = +1, s = +1/2$

B. $n = 4, l = 4, m = -4, s = -1/2$

C. $n = 4, l = 3, m = +4, s = +1/2$

D. $n = 3, l = 2, m = -2, s = +1/2$

Answer: A

Solution:

Solution:
The possible quantum numbers for $4f$ electron are
$n = 4, l = 3, m = -3, -2 - 1, 0, 1, 2, 3$ and $s = \pm\frac{1}{2}$ Of various possiblities only option (a) is possible.

Question188

Consider the ground state of Cr atom (X = 24). The number of electrons with the azimuthal quantum numbers, l = 1 and 2 are, respectively
[2004]

Options:

A. 16 and 4

B. 12 and 5

C. 12 and 4

D. 16 and 5

Answer: B

Solution:

Solution:
Electronic configuration of Cr atom ($Z = 24$)
$= 1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$
when $l = 1$, p -subshell,
Numbers of electrons $= 12$
when $l = 2$, d -subshell,
Numbers of electrons $= 5$

Question189

Which one of the following sets of ions represents the collection of isoelectronic species? (Atomic nos. : F = 9, Cl = 17, Na = 11, Mg = 12, Al = 13, K = 19, Ca = 20, Sc = 21) [2004]

Options:

A. $K^+, Cl^-, Mg^{2+}, Sc^{3+}$

B. $Na^+, Ca^{2+}, Sc^{3+}, F^-$

C. $K^+, Ca^{2+}, Sc^{3+}, Cl$

D. $Na^+, Mg^{2+}, Al^{3+}, Cl$

Answer: C

Solution:

Solution:
$_{19}K^+, _{20}Ca^{2+}, _{21}Sc^{3+}, _{17}Cl$
each contains 18 electrons.

Question190

The orbital angular momentum for an electron revolving in an orbit is given by $\sqrt{l(l+1)} \cdot \frac{h}{2\pi}$. This momentum for an s -electron will be given by
[2003]

Options:

A. zero

B. $\frac{h}{2\pi}$

C. $\sqrt{2} \cdot \frac{h}{2\pi}$

D. $+\frac{1}{2} \cdot \frac{h}{2\pi}$

Answer: A

Solution:

Solution:
For s -electron, $l = 0$
$\therefore$ Orbital angular momentum
$= \sqrt{0(0+1)}\ \frac{h}{2\pi} = 0$

Question191

In Bohr series of lines of hydrogen spectrum, the third line from the red end corresponds to which one of the following inter-orbit jumps of the electron for Bohr orbits in an atom of hydrogen
[2003]

Options:

A. $5 \rightarrow 2$

B. $4 \rightarrow 1$

C. $2 \rightarrow 5$

D. $3 \rightarrow 2$

Answer: A

Solution:

Solution:
The lines falling in the visible region comprise Balmer series. Hence the third line from red would be $n_1 = 2, n_2 = 5$ i.e. $5 \rightarrow 2$

Question192

The de Broglie wavelength of a tennis ball of mass 60g moving with a velocity of 10 metres per second is approximately
Planck's constant, $h = 6.63 \times 10^{-34}$ J s
[2003]

Options:

A. 10^{-31} metres

B. 10^{-16} metres

C. 10^{-25} metres

D. 10^{-33} metres

Answer: D

Solution:

Solution:

$$\lambda = \frac{h}{mv} = \frac{6.63 \times 10^{-34}}{60 \times 10^{-3} \times 10}$$
$$= 1.105 \times 10^{-33} \approx 10^{-33} \text{m}$$

Question193

The number of d -electrons retained in Fe^{2+} (At. no. of Fe=26) ion is [2003]

Options:

A. 4

B. 5

C. 6

D. 3

Answer: C

Solution:

Solution:
$Fe^{++}(26-2=24) = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^0 3d^6$ hence no. of d electrons retained is 6 .
[Two 4s electron are removed]

Question194

Which one of the following groupings represents a collection of isoelectronic species?(At. nos. : Cs : 55, Br : 35) [2003]

Options:

A. N^{3-}, F^-, Na^+

B. Be, Al^{3+}, Cl^-

C. Ca^{2+}, Cs^+, Br

D. Na^+, Ca^{2+}, Mg^{2+}

Answer: A

Solution:

Solution:
N^{3-}, F^- and Na^+ contain 10 electrons each.

Question195

In a hydrogen atom, if energy of an electron in ground state is $13.6 . eV$, then that in the 2^{nd} excited state is
[2002]

Options:

A. 1.51eV

B. 3.4eV

C. 6.04eV

D. 13.6eV .

Answer: A

Solution:

Solution:
2^{nd} excited state will be the 3^{rd} energy level
$E_n = \frac{13.6}{n^2} eV$
or $E_3 = \frac{13.6}{9} eV = 1.51 eV .$

Question196

Uncertainty in position of a minute particle of mass 25g in space is 10^{-5}m. What is the uncertainty in its velocity (in ms^{-1})?($h = 6.6 \times 10^{-34} J\ s$)
[2002]

Options:

A. 2.1×10^{-34}

B. 0.5×10^{-34}

C. 2.1×10^{-28}

D. 0.5×10^{-23}.

Answer: C

Solution:

Solution:

$\Delta x \cdot \Delta p = \frac{h}{4\pi}$; or $\Delta x, m, \Delta v = \frac{h}{4\pi}$

$\therefore \Delta v = \frac{6.62 \times 10^{-34}}{4 \times 3.14 \times 0.025 \times 10^{-5}} = 2.1 \times 10^{-28} ms^{-1}$